Volume 22, Number 4, February 29, 1968

NUCLEAR SCIENCE ABSTRACTS

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Index References

All index entries refer the reader to volume and abstract number:

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FOURRIER, Alain
  Radioactive chain of mass number 189,  21:10023
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Personal Authors

Every author's name is indexed in the form appearing on the document abstracted:

```
MONTH, M.
  Theory of gradient perturbations in AGS,  21:9872 (BNL-
    10899)
MONTH, Melvin
  Simple relativistic calculation of the electromagnetic
    form factors of the deuteron,  21:9744
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Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

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SHEEP
  radiation dosimetry in, measurement of lethal dose of x,
    21:8905(R) (AD-631189)
  radiosensitivity of hematopoietic system of, x,
    21:8905(R) (AD-631189)

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  construction of, for civil defense,  21:8838
  design of fallout,  21:8777(R) (AD-629736)
  design of shaft closure for,  21:8563(P)
  determination of configuration of, for ventilation,
    21:8779(R) (AD-629928)
  equipment for fallout, minimal requirements of,
    21:8782(R) (AD-631424)
  evaluation of fallout, for fire and air blast damage,
    21:8560 (URS-658-3)
  fire resistance of components of, evaluation of,
    21:8789(R) (AD-642241)
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Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

8500 (Y-1561) MIXING AND SAMPLING ENRICHED ^{235}U FLUIDS IN CYLINDRICAL STORAGE CONTAINERS. Final Report. Harrell, J. E. **(Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant).** Jan. 17, 1967. Contract W-7405-eng-26. 124p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

is indexed as:

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UNION CARBIDE CORP., OAK RIDGE, TENN. Y-12 PLANT.
  Mixing and sampling enriched 235U fluids in cylindrical
    storage containers,  21:8500 (Y-1561)
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Report Numbers

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TID-
  3311(Suppl. 2)  21-8567   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  22298           21-9915   Nucl. News, 9: No. 12, 17-21 (Dec.
                              1966)
  22298           21-9914   Nucl. News, 10: No. 1, 17-20(Jan.
                              1967)
  23267           21-9702   Phys. Rev., 152: 1171-82(Dec. 23,
                              1966)
  23267           21-8498   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23420           21-8764   Lancet, 2: 672-5(Sept. 24, 1966)
  23474           21-8528   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23478           21-8641   Dep. mn. CFSTI $3.00 cy, $0.65 mn
  23482           21-9471   Dep. mn. CFSTI $3.00 cy, $0.65 mn
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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 6619, 6799, 6803, and 7024.

6255 (KFK-610) SPEKTRALPHOTOMETRISCHE BESTIMMUNG DER WERTIGKEITEN DES PLUTONIUMS IN SALPETERSAUREN LOESUNGEN. (Spectrophotometric Determination of Pu in Nitric Acid Solution). Ochsenfeld, W.; Schmieder, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). June 1967. 23p. (In German). Dep.

A method for the rapid quantitative determination of tri-, quadri-, and quinquevalent Pu either alone or with each other in nitric acid solution was described. The absorption spectra of the particular valences in the visible region at different nitric acid and Pu concentrations were taken in aqueous and TBP-dodecane solutions. The dependence of the specific extinction value on the variables selected was determined. For determination of quadrivalent U in addition to trivalent Pu, spectra of quadrivalent U were obtained in different nitric acid concentrations. The possibility of the simultaneous spectrophotometric determination of quadrivalent U and trivalent Pu was investigated. (tr-auth)

6256 (PG-Report-775) ANALYTICAL METHOD FOR THE DETERMINATION OF STRONTIUM IN BONE, MILK, AND VEGETABLE ASHES USING THE UNICAM SP 90 ATOMIC ABSORPTION SPECTROPHOTOMETER. (United Kingdom Atomic Energy Authority, Capenhurst (England). Production Group). 1967. 6p. Dep. CFSTI. UK 1s. 2d.

Strontium and calcium were coprecipitated as oxalates from an acid solution of the ash. The dried precipitate was ignited and dissolved in hydrochloric acid. The strontium content of the solution was determined by atomic absorption spectrophotometry. (auth) (UK)

6257 (PG-Report-807) A METHOD FOR THE SEPARATE COLLECTION OF KRYPTON AND XENON FROM REACTOR COOLANT GAS IN PREPARATION FOR GAMMA SPECTROMETRIC COUNTING. French, R. L. D. (United Kingdom Atomic Energy Authority, Sellafield (England). Production Group). 1967. 9p. Dep. CFSTI. UK 1s. 9d.

The reactor coolant CO_2 is first bubbled through KOH solution. Separation of the Kr and Xe is achieved by passing a sample of the residual gas so obtained through two charcoal-filled traps cooled by liquid N_2 and solid CO_2, respectively. The traps may then be counted directly for Kr and Xe. Any Ar present is not retained by the traps, the design of which is described. (UK)

6258 (UCRL-50335) MERCURY POOL CELL FOR CONTROLLED-POTENTIAL COULOMETRY. Harrar, J. E. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 27, 1967. Contract W-7405-eng-48. 6p. Dep. CFSTI.

A detailed description of the mercury pool cell that is currently being used at LRL, Livermore, for controlled-potential coulometry is given. The cell is suitable for electrolyses involving milligram quantities of material in solution volumes of 6 ml or less. A complete electrolysis can be carried out with this cell in less than 15 min. (auth)

6259 DETERMINATION OF THE HOMOGENEITY OF ALLOYS BY AUTORADIOGRAPHY AND ACTIVATION ANALYSIS. Radwan, M.; Walis, L. (Institut fuer Kernforschung, Warsaw). Isotopenpraxis, 3: 398-403(1967). (In German).

For determining homogeneity of alloys autoradiography and activation analysis were employed. Distribution of copper and antimony in bearing alloys with a high content of tin was studied by autoradiography as a function of technological conditions. Moreover, the homogeneity of 50 steel samples was determined. The study was made by measuring the gamma radiation of ^{51}Cr, which was formed by activation when the sample was irradiated in a nuclear reactor. The examples mentioned show the possibility and the range of utilization of autoradiography and activation analysis for determining the degree of homogeneity of alloys. (auth)

6260 ON MEASURING ERRORS IN CONTENTS DETERMINATION BY BETA BACKSCATTERING TECHNIQUES. Thuemmel, H.-W. Isotopenpraxis, 3: 394-7(1967). (In German).

Quantitative considerations of the influence of fluctuations of measuring geometry (especially of distance) and air density (especially of temperature and pressure) as well as grain size (in loose materials and powder mixtures) on the fluctuation of measured values of backscattering intensity were made. It was found that the errors occurring in most of the papers known to date on the application of the beta backscattering technique to binary systems content determination of $\gtrsim 0.5\%$ may be explained by the influence of these perturbing effects. (auth)

6261 RESONANCE NEUTRONS IN ACTIVATION ANALYSIS. PART 1. THEORY. Prouza, Z.; Rakovic, M. (Charles Univ., Prague). Isotopenpraxis, 3: 389-94(1967).

The use of resonance neutrons in activation analysis is discussed. The efficiency of elimination of thermal neutrons by cadmium filter was calculated. Mathematical equations necessary for correction of neutron flux changes caused by the sample are listed. The influence of the geometrical shape of the sample on the neutron flux perturbation factor is discussed. (auth)

6262 MEASUREMENT OF ISOTOPIC RATIO OF LIGHT ELEMENTS. Horibe, Yoshio (Tokyo Univ.). Shitsuryo Bunseki, 14: No. 3, 113-20(Sept. 1966). (In Japanese).

Variations in the isotopic ratio of light elements such as H, C, O, and S provide useful information in the solution of geochemical problems. Recent technological advances enabled the relatively easy measurement of minute changes of such isotopic ratios. From the geochemical point of view, what is important is not the absolute value of isotopic ratios but their variation. That is, the deviation $\delta(0/00)$ of the isotopic ratio of a given sample (R), from that of the standard sample (R_0), is given as $\delta(0/00) = (R/R_0 - 1) \times 1000$. The method for determining the δ value is described, using a Deuterium Instrument for the Analysis of Natural Abundance (DIANA) and Physico-Analytical Device for Oxygen Relative Abundance (PANDORA). In the deviations of D and ^{18}O isotopic ratios measured with the instruments, the average deviations for δD and $\delta^{18}O$ were ± 0.2 and $\pm 0.02\%$, respectively. (NSA of Japan)

6263 MEASUREMENT OF THE ASH CONTENT IN COAL USING TWO RADIATION SOURCES-(^{137}Cs-^{241}Am). Fushimi, Hiroshi (Waseda Univ., Japan). Genshiryoku Kogyo, 13: No. 6, 47-51(June 1967). (In Japanese).

The method of coal ash analysis by radiation has many advantages: nondestructive test, short measuring time, continuous measurement, application for automatic process control, small errors, etc. The results of an investigation of the penetration technique, aimed at the development of an instrument that is rapid, has a high accuracy, and is applicable for industrial pur-

poses, are reported. The technique, employing two sources, is capable of continuous, rapid measurement of the coal ash. The instrument described can be developed into the one for high-accuracy measurement of the ash content in small samples. The technique is industrially applicable for mixed materials especially in the control of the mixing ratio of coal, cement, and others. ^{241}Am and ^{137}Cs appear to be useful for analysis of the quality of coal. (NSA of Japan)

6264 MEASUREMENT OF ISOTOPIC RATIO BY BALANCE METHOD. SOME PROBLEMS IN THE PRECISION ISOTOPE RATIO MEASUREMENT OF SULFUR BY BALANCE METHOD. Sakai, Hitoshi (Okayama Univ., Japan). Shitsuryo Bunseki, 14: No. 3, 121-5(Sept. 1966). (In Japanese).

The isotopic abundance ratio for O, C, or S can be measured with an accuracy and reproducibility of $<\pm 0.1\%$ by the balance method, if the mass spectrometer is operated under normal conditions. But in this case, it is also necessary to keep the isotope fractionation below the level of $<\pm 0.1\%$ in preparation of the gaseous samples. The processes of preparation differs from one element to another and also according to the chemical state of the element, and so the problem cannot be treated in the general way. A discussion is presented on the mechanism and extent of isotope fractionation as well as the method for minimizing the isotope fractionation, when SO_2 is prepared from the sulfides. Isotope fractionation occurs mainly in the following reactions: $Ag_2S + O_2 \rightleftharpoons SO_2 + Ag$ and $SO_2 + \frac{1}{2}O_2 \rightleftharpoons SO_3$. The SO_2 produced by the first reaction is removed from the system in the second process, and $^{34}SO_2$ exchanges with SO_3. Thus the isotopic abundance ratio is influenced by the yield of SO_2. In this case, the use of a mixture of N_2 and O_2 instead of pure O_2 may minimize the fractionation. (NSA of Japan)

6265 APPLICATIONS OF NEGATIVE SURFACE IONIZATION METHOD TO ISOTOPIC ANALYSIS. Taniguchi, Setsuo (Radiation Center of Osaka Prefecture). Shitsuryo Bunseki, 14: No. 3, 139-41(Sept. 1966). (In Japanese).

A report is made on the chemical forms of some samples analyzed by mass spectrometry and ionic species observed for some elements. For boron BO_2^- was observed from $Na_2B_4O_7$ by using the single filament system; for chlorine, using NaCl, Cl^- and ClO_4^- ions were obtained; for other halogens, F^-, Br^-, and I^- were obtained from KF, KBr(or AgBr), and KI, respectively; for cadmium with $CdCl_2$ as a sample, CdO^-, CdO_2^-, CdO_3^-, and CdO_5^- were observed; for tungsten WO_3^- and WO_4^- were obtained from a W ribbon as an ionization filament; and for rhenium ReO_2^- and ReO_4^- were obtained from a Re filament itself. Studies are also made on the application of negative surface ionization to Te, Sb, S, Se, and As. (NSA of Japan)

6266 DETECTION OF Sb AND Ba IN GUNPOWDER RESIDUES BY NEUTRON ACTIVATION ANALYSIS. Kubota, Mitsumasa (National Research Inst. of Police Sciences, Japan); Nakamura, Yutaka. Kagaku Keisatsu Kenkyusho Hokoku, 19: 261-8(Dec. 1966). (In Japanese).

An activation analysis method is described for the determination of Sb and Ba in gunpowder residue on the hands of persons firing guns. Results on 20 persons who fired a 38 caliber Smith and Wesson Revolver with special 38 caliber cartridges using primers of Teikoku Kakohin Mfg. Co. were compared with those on another 15 persons with no access to firing. The samples were gathered from the entire surface of the hands by rubbing carefully with a 4×4-cm white cotton cloth moistened with purified H_2O. Activation of the samples and standards was carried out in the Tokyo Atomic Industrial Research Laboratory, 100 kW enriched U swimming-pool type reactor. Irradiation for Sb was carried out in the core at 1.7×10^{12} n/cm^2/sec for 15 hr, and the Ba irradiation was carried out in a pneumatic tube at 5.7×10^{11} n/cm^2/sec for 2 hr. After cooling, the samples were counted on 3-in. $\times$ 3-in. well type NaI(Tl) crystal scintillation counter coupled to a 256-channel pulse height analyzer. A radiochemical separation procedure was employed for ^{122}Sb and ^{139}Ba, and a nondestructive method was used for some of the ^{122}Sb and ^{124}Sb. The autoradiograph was taken to ascertain the powder residue pattern deposited on the hand. The results of the experiments are shown in tables and figures. (NSA of Japan)

6267 RAPID DETERMINATION OF ASH IN COAL BY MEANS OF TWO RADIATION SOURCES. Takasaki, Tatsuya; Matsumoto, Masateru. (Coal Mining Research Center, Japan). Nippon Kogyo Kaishi, 83: 565-8(Mar. 1967). (In Japanese).

In determination of the ash content in coal, two radiation sources (A) and (B) of high and low energy are used simultaneously. The method is based on the fact that when the energy is higher than 200 keV the mass absorption coefficient μ is nearly constant and independent of the atomic number Z, whereas if the energy is lower than 100 keV it increases with the atomic number. Consequently, a high value of μ shows a high ash content, and thus the ash content can be given by measuring the μ value. The transmittance length and the sample size employed were 300 mm and 15 mm, respectively, and a correction was made for the water content. For source (A) ^{137}Cs was used, and for (B) ^{241}Am. A scintillation counter was used for the counting. The accuracy of the method was within 1%. (NSA of Japan)

6268 SURVEY OF FLOW AND CONTAMINATION OF RIVER BY ACTIVATION ANALYSIS OF NON-RADIOACTIVE TRACER. Kobayashi, Masatoshi (Japan Atomic Energy Research Inst.). Genshiryoku Kogyo, 12: No. 10, 39-43(Oct. 1966). (In Japanese).

Radioactive tracer measurements of the flow and dilution of a river and of underground water and water leakage are already established, but its uses for city water and usual underground water are limited because of radiation hazards. A study was made on the possibility of using a nonradioactive tracer instead of a radioactive one and performing activation analysis of the sample water collected. The advantages of this method are that there is no radiation hazard and that large flow and dilution can be determined, using large quantities of nonradioactive substances. But, it also has some drawbacks: activation analysis takes much labor and time, and contaminating substances in the river water interfere with the activation analysis of nonradioactive tracer materials. A series of experiments, using $^{24}NaCl$ and $NH_4{}^{82}Br$ as radioactive tracers and NH_4Br as an inactive tracer, were carried out in the Kanda and Nippara Rivers, in order to compare the determinations of the flow and dilution factor by the two methods. As the result, it was found that NH_4Br was a suitable nonradioactive tracer; it is necessary to investigate the adsorption loss of tracers. (NSA of Japan)

6269 APPLICATION OF ACTIVATION ANALYSIS IN CRIMINAL INVESTIGATIONS. Kozuka, Hiroshi; Niwase, Ken (National Research Inst. of Police Sciences, Japan). Kagaku Keisatsu Kenkyusho Hokoku, 19: 211-14(Sept. 1966). (In Japanese).

A general neutron activation analysis method for use in criminal investigations consists of irradiating the sample material in a polyethylene or aluminum capsule and a reference sample in the form of liquid (immersed in filter paper) or solid. The detection sensitivity is in general 10^{-6} to 10^{-11} g and slightly lower for lighter elements. The advantages and disadvantages of the method are presented. (TSS)

6270 DETERMINATION OF COSMIC-RAY-PRODUCED NUCLIDES ^{53}Mn, ^{45}Sc, AND ^{26}Al IN METEORITES BY NEUTRON ACTIVATION AND GAMMA COINCIDENCE SPECTROSCOPY. Herpers, U. (Univ. of Cologne); Herr, W.; Woelfle, R. pp 199-205 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

A number of stable and unstable nuclides formed by spallation processes are investigated by the combined techniques of neutron activation and advanced gamma spectroscopy. The need for an economic use of precious meteorite material is thus ensured. In the case of ^{26}Al, nondestructive analysis is found to be most valuable. Besides it was found that unlike ^{22}Na, which has a σ_{therm} of 9×10^4 b for neutron capture, σ_{therm} of ^{26}Al is <750 b. Intense neutron bombardment transforms the long-lived K-emitter ^{53}Mn into ^{54}Mn, which is detected by its 0.84-MeV gamma rays. Using the (n,γ) cross-section–recently derived by Millard–^{53}Mn values in the range of 60 to 600 dpm/kg are found in 10 iron meteorites, which were only ~3 g in weight. The determination is very specific and unaffected by side reactions. The attempt to use the $^{44}Ti(n^-,\gamma)^{45}Ti$ reaction for the analysis of spallogenic titanium failed because the σ_{therm} of ^{44}Ti was found to be expectedly low $\leq$10 b ^{45}Sc was determined by its ^{46}Sc gamma activity. Neutron-produced ^{60}Co was measured in Sichote Alin and Ramsdorf nondestructively. (auth)

6271 STEPWISE DETERMINATIONS OF THORIUM, PROTACTINIUM, AND URANIUM ISOTOPES AND THEIR APPLICATIONS IN GEOCHRONOLOGICAL STUDIES. Sakanoue, M.; Konishi, K.; Komura, K. (Kanazawa Univ., Japan). pp 313-29 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

A simple stepwise method for the quantitative determination of thorium, protactinium, and uranium isotopes that have favorable half-lives for Pleistocene dating was developed and applied to carbonate samples. After initial concentration by ferric hydroxide precipitation, these elements were successfully separated by using

an anion exchange column. Then the counting sources were prepared from each fraction by electrodeposition and the alpha spectrometries were carried out by a double-gridded ionization chamber with coincidence circuit to reduce the background activity. Reliable determination of very low ^{231}Pa activity could be made by using this chamber. The overall chemical yields were known from the recoveries of tracers (^{234}Th, ^{233}Pa, and ^{232}U) originally added to the sample solutions. The contamination of natural alpha radionuclides from these tracers was also examined. The ^{231}Pa growth method was applied to chemically unaltered samples. Several corals and Tridacna shells, mostly still in aragonitic crystals, were collected from the Plio-Pleistocene and Holocene (including present-day) sediments in the Ryuku Islands and their isotopic compositions were studied. The different parts of a stalagmite sample were also analyzed. For corals, the results gave close ages, within statistical errors, of countings between the ^{230}Th and ^{231}Pa method, though the systematically slightly longer ^{231}Pa ages for young corals seemed to indicate the existence of the initial protactinium in these samples. For Tridacna shells, any definite age assignment other than relative ages among specimens could not be obtained because of the inconsistency between ^{230}Th and ^{231}Pa ages, or their excess concentration over the equilibrium values. These facts may be used to study the post-depositional diagenesis within the samples. The most reliable age estimation can be made by cross-checking the ^{230}Th age with the ^{231}Pa age and the value of uranium isotopes ratio $^{234}U/^{238}U$. (auth)

6272 DEVELOPMENT OF DELAYED NEUTRON TECHNIQUE AS RAPID AND PRECISE METHOD FOR DETERMINATION OF URANIUM AND THORIUM AT TRACE LEVELS IN ROCKS AND MINERALS, WITH APPLICATIONS TO ISOTOPE GEOCHRONOLOGY. Gale, N. H. (Oxford Univ.). pp 431-52 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

The method described was developed partly to provide information on the uranium and thorium content of samples to be dated by the uranium/lead, thorium/lead and lead/lead techniques. Since the method is nondestructive and involves no chemical preparation it has the prime advantage that the same sample analyzed for uranium and thorium can also be analyzed spectrometrically for lead; for the same reason blank errors are also obviated. The method is based on the detection of delayed neutrons emitted in the decay of the fission products of uranium and thorium. Fission is induced by exposing the samples to the intense neutron flux inside a nuclear reactor. The fast neutron component induces fission principally in ^{232}Th and the slow neutron component in ^{235}U, so that by making two determinations, one in the mixed flux, one with the slow neutrons screened out by a cadmium shield, both thorium and uranium may be determined. A single determination of both uranium and thorium occupies about six minutes; the lower limits of precise measurement are at present about 5×10^{-8} g/g for uranium and 2×10^{-6} g/g for thorium. A careful investigation was made of the range of validity of the method when applied to the analysis of rocks and minerals, and it was demonstrated that the adoption of proper procedures allows all but one of the possible interference effects to be reduced to negligible proportions. The remaining interference is due to the intense γ flux emitted by the sample as a result of neutron activation of the sample matrix. It was found that this interference, largely discounted by previous workers, can be very serious for geological materials, but that it can be reduced to an acceptable level by careful design of the neutron counter. A survey of the errors involved in the method and a discussion of the reproducibility of analysis are presented. (auth)

6273 CONTINUOUS SUBSTOICHIOMETRIC DETERMINATION OF TRACES OF MERCURY BY RADIOACTIVE ISOTOPE-DILUTION ANALYSIS. Briscoe, G. B.; Cooksey, B. G.; Ruzicka, J.; Williams, M. (Univ. of Aston, Birmingham, Eng.). Talanta, 14: 1457-65(Dec. 1967).

Automatic substoichiometric analysis by isotope dilution, where the analysis is based on solvent extraction, was carried out experimentally. Preliminary experiments are described by means of which optimum conditions for this type of automated determination can be chosen, and its reproducibility and selectivity checked. As an example traces of mercury down to 5×10^{-8} g were determined, and the method was applied to the analysis of low-grade cinnabar ores. (auth) (UK)

6274 CHLORINATION OF SAMARIUM OXIDE BY VAPORS OF CARBON TETRACHLORIDE. Ivashentsev, Ya. I.; Stoyanova, M. I. (Krasnoyarskii Inst. of Non-Ferrous Metals, USSR). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol., 10: 848-51(1967). (In Russian).

Thermographic, thermogravimetric, x-ray, and chemical analyses were made on the chlorination of samarium oxide by carbon tetrachloride. Chlorination was achieved at 350 to 700°C. The most rapid conversion by samarium oxide into (up to 96%) trichloride was achieved at 550 to 650°C. (R.V.J.)

6275 PHOTOMETRIC EXTRACTION METHOD FOR DETERMINING SMALL AMOUNTS OF Nb IN STEEL. Ganago, L. I.; Buzina, N. I.; Koltashkina, S. F. (Volograd Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol., 10: 861-2(1967). (In Russian).

A photometric extraction method for the determination of Nb by converting it into a soluble complex of $H[NbO(CNS)_4]$ was used on steel containing Cr, Ni, V, and Mo. Satisfactory precision was achieved. Process duration was 30 to 40 min. (R.V.J.)

6276 EFFECTS OF IMPURITIES ON THE γ ABSORPTIOMETRIC ANALYSIS. Velyus, L. M.; Krylov, M. V. (Magnetogorsk Mining and Metallurgical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol., 10: 863-6(1967). (In Russian).

Formulas obtained confirmed the theoretical postulation on the influence of various elements on the accurate determination of a heavy component in a multicomponent medium. Experiments with ^{170}Tm γ-ray source involving measurement of the inverse scattering of the β-radiation and the intensity of γ radiation passing through the specimen achieved satisfactory results in determining all three components of ferromolybdenum with silicon and iron (41 to 51% Mo and 28 to 38% Fe). (R.V.J.)

6277 DETERMINATION OF TRACE AMOUNTS OF RARE EARTH ELEMENTS IN HOT SPRING WATER USING NEUTRON ACTIVATION ANALYSIS. Onuma, Naoki (Tokyo Univ.). Onsen Kogakkaishi, 4: No. 3, 133-41(Mar. 1967). (In Japanese).

Trace amounts of lanthanum, samarium, and europium were determined in Misasa hot spring water (76°C pH 6.9), using neutron activation analysis. The rare earth elements were coprecipitated with iron hydroxide (30 mg Fe^{3+}) from 1 and 10 l of the sample. The hydroxide precipitated was dried and subjected to neutron irradiation in the TRIGA MARK II reactor (Rikkyo University) for 3 days at a neutron flux of $\sim 5 \times 10^{11}$ n/cm^2/sec. The total rare earth element fraction was separated chemically, and the radioactivities of ^{140}La(40.2 hr), ^{153}Sm(47 hr), and ^{152}Eu(9.2 hr) were measured with a 400 channel γ spectrometer. The amount (in μg/l) found were La 1.8×10^{-2}, Sm 5.9×10^{-3}, and Eu 5.1×10^{-4}. The relative abundance (La $\equiv$ 1.00) of each element from the above data agreed with that of average granites. This fact suggests that the hot spring water in Misasa area was in contact with granitic rocks. The ion-exchange behavior of several rare earth elements, La, Ce, Pr, Nd, Sm, Eu, Gd, Dy, Er, and Lu, was examined on Diaion SK-1 cation-exchange resin with ammonium thiocyanate–hydrochloric acid solutions and on Dowex-50 cation-exchange reson with ammonium chloride–hydrochloric acid solutions. In the NH_4SCN–HCl system the distribution coefficient (K_d) of the rare earth elements decreased with increasing atomic number. The differences in K_d value were found to permit separation of the lighter rare earths. In the NH_4Cl–HCl system, the differences in K_d value increased as compared with HCl system. This fact also suggests the possibility of the separation of rare earth elements. (auth)

6278 DETERMINATION OF THE OXYGEN CONTENT IN GERMANIUM AND SILICON BY ACTIVATION WITH ^3He IONS. Aleksandrova, G. I.; Demidov, A. M.; Kotel'nikov, G. A.; Pleshakova, G. P.; Sukhov, G. V.; Choporov, D. Ya.; Shmanenkova, G. I. At. Energ. (USSR), 23: 106-9(Aug. 1967). (In Russian).

In connection with the necessary separation of materials, suitable for production of spectrometric detectors of nuclear radiation, a method for determination of oxygen in Ge and Si by irradiation with ^3He was developed. Oxide films after irradiation of the samples were removed by chemical cleansing. By means of the semiconductor Ge spectrometer, the γ spectrum of the irradiated Ge was measured and the necessity of removing ^{18}F from the masking positron emitters was shown. The proposed method for separation of fluorine gave a purification coefficient of 10^3. The possibility of analyzing for gallium arsenide, tungsten, silicon carbide, and other materials was verified. The sensitivity of the method is 10^{-5}%. (tr-auth)

6279 AUTOMATIC RADIOCHROMATOGRAPHIC SEPARATION AND DETERMINATION OF CHEMICALLY SYNTHESIZED 1,2-^{14}C-PHOSPHORYLETHANOLAMINE. Porcellati, G.; di Jeso, F. (Univ., Pavia, Italy). J. Label. Compounds, 3: 206-16(July-Sept. 1967).

An automatic radiochromatographic method for purification, separation, and quantitative determination of chemically synthesized ^{14}C-labeled phosphorylethanolamine is described. The chromatographic effluent from a cationic ion exchange resin is automatically radio-determined by passage through a flow-cell filled

with anthracene crystals and fitted on an automatic liquid scintillation spectrometer. The principal features of the system, and the methods used for determination of the radioactivity content are also described. The yield of the radioactive product was calculated to be about 75%, the rapidity of the whole process satisfactory. The processing described may be applied also for the synthesis, purification, and separation of other chemically synthesized ^{14}C-labeled "phospholipid phosphoric esters." (auth)

6280 EFFECT OF THE SUCCESSIVE APPEARANCE OF THE SPECTRAL LINES OF MOLYBDENUM WITH DIFFERENT EXCITATION POTENTIALS. Orlov, A. G. Zh. Prikl. Spektrosk., Akad. Nauk BSSR, 7: 416-18(Sept. 1967). (In Russian).

The effect of successive appearance of spectral lines of Mo with different excitation potentials during analysis of impurities in lead telluride was described. The effect was explained by the fundamental change of the molecular form of Mo and the conditions of the thermal excitation at first and at the end of the exposure. As a result, favorable conditions were created for the appearance of lines of atoms and ions with very high excitation potential. The possibility of a similar and more severe effect in quantitative spectral analysis was considered and the selection of the analytical lines and excitation conditions is discussed. (tr-auth)

6281 AEROSOL-SPARK METHOD OF ANALYSIS AND ITS USE FOR THE DETERMINATION OF RARE EARTH ELEMENTS. Tarasevich, N. I.; Gusarskii, V. V. Zavod Lab., 33: 1091-4(1967). (In Russian).

Some characteristics of the spectral aerosol-spark analysis method were examined generally with respect to the majority of the elements of the periodic table. As an example of the utility of the method, the analysis of mixtures of all 14 rare earth elements is described. (tr-auth)

6282 FAST NEUTRON ANALYSIS OF RARE EARTH ELEMENTS. Plaksin, I. N.; Starchik, L. P.; Tustanovskii, V. T. (Skochinskii Inst. of Mining). Zavod. Lab., 33: 1098-1100(1967). (In Russian).

The determination of rare earth elements is done by fast neutrons through the reaction (n,2n), appearing with predominant inelastic processes at $E_n = 14$ MeV. For activation of the neutrons, a T(d,n) generator with yield of 5×10^8 neutrons/sec at a voltage of 130 kV was used. The samples to be analyzed were pneumatically transported for measurement of the induced activity in scintillation spectrometers with anticoincidence shields. The anticoincidence spectrometer significantly reduced the Compton scattering in the recording range of the γ spectra. The sensitivity threshold for the determination of oxides of the elements for 10-g samples is 3×10^{-3}% for Tb, 8×10^{-3}% for Er, 4×10^{-4}% for Pr, 3×10^{-2}% for Sm, 1.3×10^{-2}% for Y, 10^{-3}% for Ce, and 3×10^{-3}% for Nd. (tr-auth)

6283 DETERMINATION OF NITROGEN IN PURE NIOBIUM BY NEUTRON ACTIVATION AT 14 MeV. Barit, I. Ya.; Kudinov, B. S.; Musaelyan, R. M.; Pronman, I. M. Zavod. Lab., 33: 1108-9(1967). (In Russian).

A method for the activation determination of nitrogen in Nb, not requiring the destruction of the sample, was described. Methods for increasing the sensitivity of the method were investigated. (tr-auth)

6284 DETERMINATION OF OXYGEN IN NIOBIUM AND TITANIUM BY FAST NEUTRON ACTIVATION. Andreev, A. V.; Barit, I. Ya.; Pronman, I. M. Zavod. Lab., 33: 1105-7(1967). (In Russian).

A reliable nondestructive fast method (3 to 5 min for one analysis) for determination of the oxygen content in Nb and Ti by fast neutron activation at 14 MeV was developed. The sensitivity of the method is 2×10^{-3}%. Results of the proposed method agree well with the results of the vacuum fusion method and isotope dilution method. (tr-auth)

6285 SENSITIVITY OF THE DETERMINATION OF OXYGEN BY FAST NEUTRON ACTIVATION. Nikolaenko, O. K.; Shtan, A. S. Zavod. Lab., 33: 1102-5(1967). (In Russian).

Methods for increasing the sensitivity of the determination of oxygen by fast neutron activation were examined. The optimum duration of irradiation and registration was determined by repeated measurements. Data on the sensitivity of the analysis were obtained by use of the pulsed neutron generator NGI-1. (tr-auth)

6286 MEASUREMENT OF THE γ-QUANTA FROM THE RADIATION CAPTURE OF NEUTRONS FOR THE DETERMINATION OF THE CADMIUM AND BORON CONCENTRATION IN ENRICHMENT PRODUCTS. Plaksin, I. N.; Malysheva, N. G. Starchik, L. P.; Zdanovich, I. D. Zavod. Lab., 33: 1100-02 (1967). (In Russian).

For determination of the cadmium content in products of metallic reprocessing and of boron in products of enrichment, γ quanta, released during the capture of thermal neutrons by the nuclei of these elements, were used. The γ-quantum yield from the capture is proportional to the content of cadmium and boron. For recording the γ quanta, a gas discharge counter of the STS-6 type of NaI(Tl) scintillation crystals, permitting registration of γ quanta with energy of 0.56 and 0.47 MeV, was used. This makes it possible to determine B and Cd separately. (tr-auth)

6287 METHOD AND APPARATUS FOR DETERMINING THE CONTENT OF CHEMICAL ELEMENTS OR COMPOUNDS IN SPECIMENS. Dolenko, Anatoly Vasilievich; Egiazarov, Boris Grigorievich; Isakov, Lev Mikhailovich; Goldansky, Vitaly Iosifovich; Makarov, Evgeny Fredovich; Trukhtanov, Veniamin Alexandrovich (to Sojuzny Nauchno-Issledovatelsky Institut Priborostroenia). British Patent 1,093,209. Nov. 29, 1967. Filed Apr. 15, 1966.

A nondestructive method is described for determining the content of a chemical isotope, element, or compound by irradiating the specimen with γ quanta, which undergo resonance absorption and scattering by an element or an isotope of the element being analyzed, and recording the number of pulses from a detector of γ quanta transmitted by or scattered from the specimen. The content of the component of interest is determined by calculating a quantity ϵ that is proportional to the content of the element, isotope, or compound of interest in the specimen from the formula $\epsilon = (|N_\infty - N_0|/N_\infty - N_b)$ in which N_∞ is the number of pulses recorded with the source and specimen being oscillated with respect to each other at an amplitude and frequency so chosen as to disturb the resonance conditions for most of the oscillation period; N_0 is the number of pulses recorded with the source and test specimen at rest with respect to each other; and N_b is the number of pulses recorded with the source and test specimen at rest with respect to each other, the resonance component of radiation from the source being filtered off. (B.L.M.)

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Refer also to abstracts 6398, 6407, 6938, 7590, and 7805.

6288 (COO-1140-167) [HIGH TEMPERATURE CHEMISTRY]. Progress Report for the Period November 1, 1966-October 31, 1967. (Kansas Univ., Lawrence. Dept. of Chemistry). Oct. 31, 1967. Contract AT(11-1)-1140. 22p. Dep. CFSTI.

Research is being carried out on phase behavior of refractory systems, crystallographic properties, vaporization, high-molecular-weight inorganic gaseous species, kinetics of high-temperature reactions, and chemical transport reactions. Equipment development is described. (M.C.G.)

6289 (IS-T-184) GAS CHROMATOGRAPHY AND FRAGMENTATION-GAS CHROMATOGRAPHY OF DIPHOSPHINE OXIDES AND URANYL NITRATE-DIPHOSPHINE OXIDE COMPLEXES. Guerin, Michael Richard (Ames Lab., Iowa). Nov. 1967. Contract W-7405-eng-82. 167p. Dep. CFSTI.

Thesis.

A 4-ft 0.25-in. OD, column of 5% SE-30 on DMCS-treated Chromosorb G operated at 290°C with a carrier gas (He) flow rate of 120 ml/min was found well suited for the gas chromatography of the diphosphine oxides provided that glass columns and glass-lined inlets are employed. Loss of sample to column adsorption and to thermal decomposition was found minimal. Adjusted retention distances of the diphosphine oxides were found related to their boiling points and the number of methylene groups in their respective methylene bridges. Flame ionization detector response factors and quantitative detection limits ($\sim 10^{-6}$M) are obtained for the diphosphine oxides. Electrical discharge fragmentation-gas chromatography patterns were obtained for the diphosphine oxides and uranyl nitrate-diphosphine oxide complexes. Patterns obtained with programmed column temperatures are found sufficiently compound specific to allow the identification of the diphosphine oxides but are not significantly influenced by complexation. Patterns obtained at ambient column temperatures are found useful for the identification of the alkyl side chains of the diphosphine oxides and found to exhibit complexation influences. Compounds are assigned to the peaks making up the ambient column temperature patterns and the influence of complexation is related to the metal content of the fragmented sample. The effects of operating parameters on the ambient column temperature fragmentation patterns are discussed. The relationship $\Delta R_m = (b/100)\delta I$ is shown useful for the computation of retention indices for the fragments making up fragmentation patterns. (auth)

6290 (IS-T-186) KINETICS FOR THE RATE OF EXCHANGE OF BROMIDE WITH CIS-DIBROMODIAMMINEPLATINUM(II). Gano, David Ronald (Ames Lab., Iowa). Nov. 1967. Contract W-7405-eng-82. 58p. Dep. CFSTI.

Thesis.

The equilibrium quotients at 0.05 M ionic strength for the aquation reactions of cis-$Pt(NH_3)_2Br_2$ were determined at 25 and 35°C. The values found for K_1 and K_2 were 9.6×10^{-4} M and 9×10^{-5} M at 25°C. At 35°C they were 1.19×10^{-3} and 1.5×10^{-4} M. The isotopic exchange could be characterized equally well by two different kinetic schemes. The first scheme consisted of three paths for exchange of bromide ligands with Br^-. The first of these was the reversible aquation reaction of cis-$Pt(NH_3)_2Br_2$. The rate for this path was $k_1[Pt(NH_3)_2Br_2]$. The second of these paths was a direct exchange of bromide with cis-$Pt(NH_3)_2Br_2$ for which the rate was $k_{Br}[Br^-][cis\text{-}Pt(NH_3)_2Br_2]$. The reversible aquation of $Pt(NH_3)_2Br(H_2O)^+$ was the third path for this kinetic scheme; $k_2[Pt(NH_3)_2Br(H_2O)^+]$ was the rate for this process. Values for the rate constants, k_1, k_2 and k_{Br}, were $3.0 \times 10^{-5}sec^{-1}$, $2 \times 10^{-4}sec^{-1}$, and $3.3 \times 10^{-4}M^{-1}sec^{-1}$ for this first scheme at 25°C. The value of k_2 appeared to be unusually high. It should be noted that the exchange could be characterized equally well if the value of k_2 were given a lower value and another means for exchange of bromide with $Pt(NH_3)_2Br(H_2O)^+$ via a "dimer" path were provided. The rate for this path would be $k_{d2}[Pt(NH_3)_2Br(H_2O^+)][cis\text{-}Pt(NH_3)_2Br_2]$. For this scheme at 25°C k_1 and k_{Br} retained their same values, but k_2 was now $3 \times 10^{-5}sec^{-1}$ and the additions rate constant, k_{d2}, was $0.12\ M^{-1}sec^{-1}$. k_1 was also determined from k_{-1}, the rate constant for the anation of $Pt(NH_3)_2Br(H_2O)^+$, and the equilibrium quotient. The two values were in good agreement. (auth)

6291 (KFK-580) DIE CHELATBILDUNG DER DREIWERTIGEN TRANSPLUTONIUMELEMENTE MIT NITRILOTRIESSIGSAEURE UND IHREN DERIVATEN. (Chelate Formation of Trivalent Transplutonium Elements with Nitrilotriacetic Acid and its Derivatives). Ali, Sameh Abdel Hadi (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). June 1967. 71p. (In German). Dep.

The chelate formation of the trivalent actinides Am, Cm, and Cf with nitrilotriacetic acid and its derivatives nitrilodiaceticmonopropionic acid, nitrilidiaceticmonobutyric acid, and nitrilodiaceticmonovaleric acid was investigated using an ion exchange method. In order to determine the suitability of the ion exchange method, the previously known chelate of Ce(III) with nitrilotriacetic acid was introduced into the investigations. The stability constants obtained agree with the literature values of the Ce(III) chelate. For attainment of ion-exchange equilibrium in the system Dowex-0.1 $M(NH_4,H)ClO_4$, contact times of 12 hours is necessary for Ce and of 48 hours for the transuranic elements. The distribution coefficient q_0 of the free metal cations is affected strongly by the ionic strengths of the aqueous phase. With increasing ionic strengths the distribution coefficient first decreases rapidly, but at higher ionic strengths it attains a constant value. At constant ionic strength q_0 and pH2 to pH4, q_0 is independent of the H ion concentration of the solution. The distribution coefficients found were 4.30×10^5 for Ce(III), 7.76×10^5 for Am(III), 8.75×10^5 for Cm(III), and 4.92×10^5 for Cf(III). Nitrilotriacetic acid forms with the four metals 1:1 and 1:2 chelates. Their total stability constants were given. Nitrilodiaceticmonopropionic acid also forms with the three elements 1:1 and 1:2 chelates. A H complex with the composition $MeHNDEP^+$ is also formed. The total stability constants of the chelates are given. Nitrilodiaceticmonobutyric acid and nitrilodiaceticmonovaleric acid gave with the trivalent Am only the H complex. The 1:2 chelates of the elements are absorbed on an ion exchanger and extracted by quaternary amines. The dissociation constants of the acids used were determined. The activity coefficient of the H in ClO_4^- medium at 25°C and ionic strength 0.1 is 0.834. (tr-auth)

6292 (UCRL-17875) THE SOLUTION ABSORPTION SPECTRUM OF Bk^{3+} AND THE CRYSTALLOGRAPHY OF BERKELIUM DIOXIDE, SESQUIOXIDE, TRICHLORIDE, OXYCHLORIDE, AND TRIFLUORIDE. Peterson, Joseph Richard (California Univ., Berkeley. Lawrence Radiation Lab.). Oct. 1967. Contract W-7405-eng-48. 102p. Dep. CFSTI.

Thesis.

The physical and chemical properties of berkelium and its compounds are being studied. A total of ~30 μg ^{249}Bk was made available for use in this study. The procedures used to purify the ^{249}Bk solution are discussed in detail, as are the analytical techniques used to evaluate the purity of the Bk sample following each purification cycle. Repeated purifications were necessary to maintain the Bk samples in a state of high purity, since ^{249}Bk decays to ^{249}Cf at the rate of ~0.2% per day. The experimental techniques used to study the Bk^{3+} solution absorption spectrum are discussed. The composite results of the observed spectra yielded 16 Bk^{3+} absorption peaks in the wavelength region 320 to 700 mμ. The two most intense peaks observed were at 418 and 474 mμ. The experimentally determined, electronic energy levels of Bk^{3+} were compared with theoretically derived values; however, no attempt to fit the observed data to the theoretical energy level scheme was made. Mention is made of an unsuccessful attempt to observe the Bk^{4+} solution absorption spectrum. A discussion of the techniques to prepare a series of compounds on a single, submicrogram sample of material is given. These techniques were employed to prepare five compounds of berkelium. The conditions used to prepare these five Bk compounds are given, along with a discussion of the treatment of the data obtained from x-ray examination of the compound samples. All samples of BkO_2 exhibited the fluorite-type, face-centered cubic structure with the "purest" sample yielding a lattice parameter $a_0 = 5.334 \pm 0.001$ Å. The dioxide stoichiometry was assumed, as was that of the Mn_2O_3-type cubic sesquioxide. The "purest" sample of Bk_2O_3 yielded a cubic lattice parameter $a_0 = 10.889 \pm 0.003$ A. The effect of time on both of these lattice parameters is noted. These lattice parameter error limits represent the 95% confidence interval reflecting only the internal consistency of the data for these particular preparations. The structure exhibited by $BkCl_3$ samples was the UCl_3-type hexagonal structure having lattice parameters $a_0 = 7.382 \pm 0.002$ and $c_0 = 4.127 \pm 0.003$ Å. Samples of BkOCl exhibited the PbFCl-type tetragonal structure having lattice parameters $a_0 = 3.966 \pm 0.004$ and $c_0 = 6.710 \pm 0.009$ Å. The lattice parameter error limits reported for $BkCl_3$ and BkOCl are the 95% confidence interval calculated using the standard statistical method for the average of three independent determinations. BkF_3 samples exhibited two crystal structures, a low-temperature, YF_3-type orthorhombic structure and a high-temperature, LaF_3-type trigonal structure. "Best estimates" for the lattice parameters of these two BkF_3 modifications are: $a_0 = 6.70 \pm 0.01$ A, $b_0 = 7.09 \pm 0.01$ A, $c_0 = 4.41 \pm 0.01$ A (orthorhombic) and $a_0 = 6.97 \pm 0.01$ A, $c_0 = 7.14 \pm 0.01$ A (trigonal). The lattice parameter error limits reported here are empirical, reflecting the uncertainties in the derivation of the lattice parameters. Comparisons of the lattice parameters of these berkelium compounds with those of similar actinide compounds consistently showed evidence of the "actinide contraction." Calculations of the Bk^{3+} radius from the crystallographic data of Bk_2O_3, $BkCl_3$, and BkF_3 are tabulated. With reference to these calculations the limitations of the concept of ionic radius are discussed. (auth)

6293 MEASUREMENT OF THE VISCOSITY OF HYDROGEN ISOTOPES ALONG THE VAPOR PRESSURE CURVE. Konareva, V. G.; Rudenko, N. S. (Physical-Technical Inst., Kharkov). Zh. Fiz. Khim., 41: 2387-8(Sept. 1967). (In Russian).

The viscosity of hydrogen isotopes along the equilibrium curve was measured in all areas of their existence in the liquid state. The viscosity coefficient increased with increases in the isotopic mass; for deutero hydrogen it was equal to the semisum of the coefficient of the viscosity of hydrogen and deuterium. (tr-auth)

6294 MEASUREMENT OF THE THERMAL DIFFUSION FACTORS AND DETERMINATION OF THE MOLECULAR INTERACTION POTENTIALS OF GASEOUS URANIUM HEXAFLUORIDE. Kirch, P.; Schuette, R. (Technische Hochschule, Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Z. Naturforsch., 22a: 1532-7(Oct. 1967). (In German).

Measurements of the thermal diffusion of gaseous U hexafluoride in a thermal diffusion tube of concentric Ni tubes showed that the thermal diffusion factor α between 328 and 452°K is negative and at 384°K reaches an extreme value of -2.9×10^{-3}. Below 328°K and over 452°K α possesses a positive sign. The measured temperature dependence of the thermal diffusion factor of UF_6 can be quantitatively described by assumption of an interaction law of the modified Buckingham potential type, when the values $\underline{s} = 14.75$ and $\frac{\epsilon}{k} = 582$°K were used for the potential parameter. By use of an experimental viscosity value, the third potential parameter $\underline{r}_m = 5.44$ Å was determined. With the molecular interaction potential thus established the absolute value and the temperature dependences of all transport coefficients and of the second virial coefficient could be theoretically described in agreement with the latest measurement values. (tr-auth)

6295 POSITION OF LANTHANUM AND LUTETIUM IN THE PERIODIC TABLE. Merz, H.; Ulmer, K. (Technische Hochschule, Karlsruhe, Ger.). Phys. Lett., 26A: 6-7(Dec. 4, 1967).

X-ray isochromats show, that the densities of states in the conduction band of transition metals are very similar in the sense of a rigid band model. With respect to this general scheme only lutetium, but not lanthanum, may be considered as a transition metal. (auth)

6296 PHOTOLYTIC DEGRADATION OF CELLULOSE TRIACETATE. Chen, Catherine S. Hsia; Jankowski, Stanley; Brother, Allen (Celanese Corp. of America, Summit, N. J.). Advan. Chem. Ser., No. 66, 240-55(1967).

From American Chemical Society, 151st Meeting, Pittsburgh, Mar. 22-31, 1966. See CONF-660320.

The degradation of cellulose triacetate induced by ultraviolet radiation was investigated in air and in vacuum, using mercury lamps. Volatile products were ascertained by mass spectrometry as formed during irradiation, and the resulting polymers were characterized by viscosity measurements and functional group analysis. After a small radiation dose, in vacuum, anhydrous cellulose triacetate yielded carbon monoxide and ketene as volatile products. In air, oxygen uptake was the main initial reaction; virtually no volatile material was detected even after a large total dose. Both in vacuum and in air, residual moisture in the polymer influenced degradation. The photolysis of related monomeric compounds was studied, and the reaction products were characterized. (auth)

6297 INTERACTION OF SODIUM CHLORIDE WITH DYSPROSIUM AND GADOLINIUM CHLORIDES. Orlov, K. V.; Kozlov, V. G.; Pospelova, N. G. pp 57-9 of High-Purity Metals and Alloys. Fabrication, Properties, and Testing. Emel'yanov, V. S.; Evstyukhin, A. I. New York, Consultants Bureau, 1967.

The thermal analysis results for $NaCl-GdCl_3$ and $NaCl-DyCl_3$ systems are presented both graphically and in tabular form. Thermal analysis suggests that the $NaCl-GdCl_3$ system forms a chemical compound $Na_3GdCl_6(GdCl_3 \cdot 3NaCl)$, m.p. 500°C. The system $NaCl-DyCl_3$ forms two compounds, $NaDyCl_4(DyCl_3 \cdot NaCl)$, m.p. 430° ± 5°C and $Na_2DyCl_5(DyCl_3 \cdot 2NaCl)$, m.p. 500° ± 2°C. Calculations for the liquidus line indicates that complex ions of composition $[GdCl_6]^{3-}$, $[DyCl_4]^-$, and $[DyCl_5]^{2-}$ are probably present in the melts. (B.L.M.)

6298 ON THE REACTIVITY OF ORGANIC COMPOUNDS (KINETIC STUDIES OF HYDROGEN ISOTOPE EXCHANGE IN NON-AQUEOUS SOLUTIONS). Shatenshtein, A. I. (Inst. of Physics and Chemistry, Moscow). Kinet. Kataliz, 8: 1056-72 (Sept.-Oct. 1967). (In Russian).

Data on measurements of kinetics of hydrogen isotopic exchange in anhydrous solutions with base or acid catalyst are reviewed. The efficiency of such measurements for investigation of reactions of separate C−H bonds of organic compounds as a function of their structure or reagent media and for studying mechanisms of reactions was evaluated using various examples. Data on the kinetics of exchange reactions were used in production of compounds containing deuterium or tritium in certain molecules. (36 references) (R.V.J.)

6299 RAl_3 COMPOUNDS IN RARE EARTH–ALUMINUM SYSTEMS AND THEIR CRYSTAL STRUCTURES. Zalutskii, I. I.; Kripyakevich, P. I. (Lvov State Univ.). Sov. Phys.-Cryst. (Engl. Transl.), 12: 341-3(Nov.-Dec. 1967).

Translated from Kristallographiya, 12: 394-7(May-June 1967).

The existence of compounds of the type RAl_3, where R is La, Pr, Nd, Yb, Lu, or Sc, was established and their crystal structures were determined. The compounds $LaAl_3$, $PrAl_3$, and $NdAl_3$ have the Ni_3Sn structure, and the compounds $YbAl_3$, $LuAl_3$, and $ScAl_3$ have the $AuCu_3$ structure. (auth)

6300 REACTION OF UC_2 WITH NITROGEN. Sudo, Kingo; Tanno, Teruho (Tohoku Univ., Japan). Tohoku Daigaku Senko Seiren Kenkyusho Iho, 22: No. 2, 121-6(Dec. 1966). (In Japanese).

Fundamental studies were made on the reaction rate between UC_2 and nitrogen in the range from room temperature to 1,000°C with a thermobalance in nitrogen current at about 1 atm. Within the heating rates and the flow rates of nitrogen adopted in these studies, there was no influence at the initial temperature of reaction. The sample was heated at a rate of 190°C/hr and its weight change was measured. The reaction began at 530°C, proceeded rapidly above 630°C and very slowly above 950°C. The amount of weight gain of the sample agreed with that calculated from the following reaction: $UC_2 + \frac{3}{4}N_2 \rightarrow \frac{1}{2}U_2N_3 + 2C$. The rate determining step was considered to be a surface reaction of the powder. The reaction rate was measured for the initial reaction in the temperature range from 590 to 660°C and the activation energy calculated by Arrhenius formula was about 27 kcal/mol. (auth)

6301 KINETIC ISOTOPE EFFECTS IN PROTON-TRANSFER REACTIONS. Jones, J. R. (Univ. of British Columbia, Vancouver). Chem. Commun., No. 14, 710-11(1967).

Previously reported studies on the base-catalyzed exchange of aromatic hydrocarbons in lithium cyclohexylamide–cyclohexylamine, or dimethyl sulfoxide (Me_2SO) containing potassium butoxide, indicated considerable discrepancies in the relative rates of proton exchange. A k_D/k_T value of near unity has been reported for the alkoxide-catalyzed exchange of the methyl hydrogens of toulene, in sharp contrast to a k_H/k_D value in excess of 10 when the reaction was catalyzed by lithium cyclohexylamide in cylcohexylamine. An attempt was made to show that the two widely different isotope effect values are not inconsistent and that both may relate to the same rate-determining ionization mechanism. Measurements in the tert-butoxide−2-methyl-2-propane−Me_2SO system indicated an increase in the rate of ionization as the concentration of Me_2SO was increased due to the increasing ease with which the desolvation of the butoxide ion occurs. Although the basicity of the medium was increased, the position of the proton in the transition state remained substantially the same. Calculations indicated little change in k_H/k_D values, which are not incompatible with a rate-determining ionization process. (J.G.B.)

6302 HALOGENATION OF KETONES. VIII. STUDIES ON THE MECHANISMS OF THE TWO BASE-CATALYZED HALOGENATIONS OF 2-BUTANONE. INDICATIONS OF NON-ENOLIC MECHANISMS. Rappe, Christoffer (Uppsala Univ.). Acta Chem. Scand., 21: 1823-32(1967).

The mechanisms of the two base-catalyzed halogenations of 2-butanone (Hal B I and Hal B II) were studied. In both reactions brominations were found to be faster than iodinations. Halogenations in D_2O provided additional support for the hypothesis that halogenation of this ketone follows a different mechanism from that of the base-catalyzed deuteration, in which reaction an enolization is involved. Nonenolic ketonic components are proposed in both halogenations. (auth)

6303 SIMPLE PYRIMIDINES. PART IX. DEUTERIUM EXCHANGE OF C-METHYL PROTONS. Batterham, T. J.; Brown, D. J.; Paddon-Row, M. N. (Australian National Univ., Canberra). J. Chem. Soc. (B), No. 3, 171-3(1967).

Proton magnetic resonance spectroscopy was used to study the hitherto unobserved deuterium exchange of C-methyl protons in pyrimidines. Acid-base catalysis was found to be operative and a concerted mechanism is proposed for the acid-catalysed reaction. (auth) (UK)

6304 OXYGEN MOBILITY AND CATALYTIC ACTIVITY OF RARE EARTH OXIDE IN RELATION TO HYDROGEN OXIDATION REACTION. Antoshin, G. V.; Minachev, Kh. M.; Dmitriev, R. V. Izv. Akad. Nauk SSSR, Ser. Khim., No. 8, 1864-6(Aug. 1967). (In Russian).

The maximum activity with respect to the oxidation of hydrogen was shown by the rare earth oxides. They are characterized by a high oxygen mobility. From the results it is suggested that the most active oxides of the rare earths must have good catalytic properties with respect to other oxidation processes. (tr-auth)

6305 INVESTIGATION OF THE SEPARATION OF THE PRINCIPAL LEVELS OF NEODYMIUM IN COMPLEXES. Ternovaya, T. V.; Yatsimirskii, K. B.; Kostromina, N. A. Zh. Prikl. Spektrosk., Akad. Nauk BSSR, 7: 405-9(Sept. 1967). (In Russian).

The absorption spectra of Nd complexes was investigated on high-resolution instruments in the regions of 430 nm (transition $^4I_{\frac{9}{2}} \rightarrow {}^2P_{\frac{1}{2}}$) and 520 nm (transition $^4I_{\frac{9}{2}} \rightarrow {}^4G_{\frac{5}{2}}$). The sublevels of the splitting of the principal levels of Nd ($^4I_{\frac{9}{2}}$) were separated for complexes with gluconic acid (HGH_4), iminodiacetic acid (IMDA), (bishydroxyethyl)glycine (DGI), nitrilotriacetic acid (NTA), ethylenediaminetetraacetic acid (EDTA), cyclohexanediaminetetraacetic acid (CDTA), diethylenetriaminepentaacetic acid (DTPA), 1,2-bis-β-aminoethoxyethane-N,N,N′,N′-tetraacetic acid (EGTA), 1-2-bis-2-aminoethyl ester of N,N,N′,N′-tetraacetic acid (EEDTA) and hydroxyethyliminodiacetic acid (HIMDA). The number of sublevels in all the complexes investigated was equal to five, which matches a noncubic symmetry. The magnitude of the splitting is a minimum in aqua ions (375 ± 5 cm^{-1}) and in complexes measures from 395 to 485 cm^{-1}. According to the increase of the splitting in the complexes of equimolar composition, the ligands can be arranged in the series NTA, EDTA, HIMDA, DGI < CDTA < EEDTA < DTPA < EGTA. In formation of the complexes with two ligands the splitting is not significantly increased. The population of the sublevel splittings for aqua ions and the complexes investigated was calculated at room temperature. It was shown that less than 50% of the complexes occur in the ground states. (tr-auth)

6306 ISOTOPIC EXCHANGE OF ACTIVE METHYL HYDROGENS. V. REACTIVITY OF α- AND γ-METHYL GROUPS AND β-HYDROGENS IN PYRYLIUM SALTS. Gard, Eugenia; Vasilescu, Alice; Mateescu, G. D.; Balaban, A. T. (Inst. of Atomic Physics, Bucharest). J. Label., Compounds, 3: 196-205 (July-Sept. 1967).

The deuteration and dedeuteration of 2,4,6-trimethylpyrylium perchlorate in water (D_2O and H_2O, respectively) was studied by

nuclear magnetic resonance using as a quantitative standard for protons tetramethylammonium bromide. γ-Methyl groups exchange faster than α-methyl groups; β-standing hydrogens exchange very slowly. A mechanism involving anhydrobase and pseudobase formation is discussed and theoretical calculations are mentioned. Geminal hydrogen–deuterium spin–spin coupling in incompletely deuterated methyl groups was observed. (auth)

6307 HYDROGEN-DEUTERIUM EXCHANGE IN SOME POLYAZAINDENES. Paudler, W. W.; Helmick, L. S. (Ohio Univ., Athens). Chem. Commun., No. 8, 377-8(1967).

Previous results indicated an increased facility for proton exchange with increase of positive charge on the N-atom of pyridine derivatives, and that the ground states of many polyazaindenes include considerable contributions due to zwitterionic structures. In view of these considerations it is predicted that the polyazaindenes will undergo deuterium exchange under conditions similar to those in the pyridine series, and the results of a preliminary study of the deuteration of some of these compounds are described. Data for deuterium exchange under both acid and base catalysis are tabulated. None of the compounds exchanged deuterium in D_2O at 100°C. The position of substitution was established by NMR spectroscopy. (UK)

6308 NUCLEAR SPIN RELAXATION IN GASEOUS METHANE AND ITS DEUTERATED MODIFICATIONS. Bloom, Myer; Bridges, Frank; Hardy, Walter N. (Univ. of British Columbia, Vancouver). Can. J. Phys., 45: 3533-54(Nov. 1967).

The spin-lattice relaxation time T_1 for protons and deuterons in CH_4, CH_3D, CH_2D_2, CHD_3, and CD_4 was measured as a function of density ρ and temperature T for 0.1 Amagat $\leq \rho \leq$ 8 Amagats and 100°K $\leq T \leq$ 300°K. The results are interpreted, using the approximation that the correlation function of each operator in the angular momentum coordinates is expressed as a product of the free molecule correlation function and an exponentially decaying function of time. The proton spin relaxation is found to be due to the spin-rotation interaction, while the deuteron spin relaxation is due to the intramolecular quadrupolar interaction. (auth)

6309 THE KINETIC ISOTOPE EFFECT. I. A THEORETICAL STUDY OF THE TRANSITION STATE IN THE SOLVOLYSIS OF BOROHYDRIDE AND BORODEUTERIDE. II. A QUEST FOR PROTON TUNNELLING. RE-EXAMINATION OF THE ISOTOPIC RATE CONSTANT RATIO FOR THE REACTION BETWEEN 2-NITROPROPANE AND 2,6-LUTIDINE. Lehman, Thomas Alan. Lafayette, Ind., Purdue Univ., 1967. 183p.

A theoretical study of the kinetic isotope effect in the solvolysis of borohydride and borodeuteride is presented. The reactions in water are $BH_4^- + H_3O^+ + 2H_2O \xrightarrow{k_H} H_3BO_3 + 4H_2$, $BD_4^- + H_3O^+ + 2H_2O \xrightarrow{k_D} H_3BO_3 + 4HD$. BH_3 and BH_4D are formed in the transition states for the rate-determining steps in the respective reactions. Computer programs were used to find the vibrational eigenfrequencies of the ground states (BH_4^- and BD_4^-) and the transition states (BH_5 and BD_4H), and to evaluate k_H/k_D in terms of partition functions, according to transition state theory. Force constants in the transition state were systematically varied between the reactant values and the product values in order to find the extent of bond making and bond breaking. Three geometrical types of models for the transition state was tested: a symmetric top, a trigonal bipyramid and a bent bond. The symmetric top model, in which a proton approaches along a B–H or B–D bond axis, provided the best description of the transition state. The breaking B–H bond was stretched to two times its ground state length. The computation was based on gas phase partition functions. The reaction occurred in solution, where molecular rotation was obstructed by the solvent. To take this into account, the observed ratio of Arrhenius frequency factors, A_H/A_D, was assumed to be the temperature-independent contribution to the computer k_H/k_D ratios. The best computed value of $E_a^D - E_a^H$, the difference in activation energies, was –304 cal/mole, which differs by 5.3% from the experimental value –321 cal/mole. The computed value of k_H/k_D at 300°K was 0.708, in agreement with experiment. The fraction of bond making and bond breaking for this computation was 0.34. The symmetric top model was explored more generally as a function of temperature, transition state force constants and bond lengths. In all computations the difference in zero-point energy between the ground and transition states is the primary factor in determining the magnitude of the kinetic isotope effect. Kinetic studies of the acid–base reaction between 2-nitropropane and 2,6-lutidine in 70% water–30% ethanol is described. A proton was removed from the second carbon of 2-nitropropane in the rate determining step. The analogous reaction of 2-nitropropane-2-d was also studied, in order to determine k_H/k_D. Triiodide was used to react with a product, $CH_3C(NO_2)CH_2^-$. The reaction was followed spectrophotometrically by observing the disappearance of triiodide at 357.3 mμ. Rate constants were obtained in the range 20 to 40°C. The following equations are found from a least-squares analysis of the data: $k_H = 2.07 \times 10^5\ e^{-13700/RT}\ M^{-1}sec^{-1}$, $k_D = 581\ e^{-11600/RT}\ M^{-1}sec^{-1}$, $k_H/k_D = 354\ e^{-2100/RT}$. The activation energies are in cal/mole. The pre-exponential ratio, A_H/A_D, was much greater than unity, which is opposite to the effect that is expected for proton tunnelling. Competition experiments, in which 2-nitropropane and 2-nitropropane-2-d were present in the same system, support the observed results. (Disser. Abstr.)

6310 REACTION OF THE HD^+ ION WITH VARIOUS RARE GASES. Berta, Michael Anthony. Baltimore, Johns Hopkins Univ., 1965.

Thesis.

The reaction

$$X + HD^+ \rightarrow \begin{cases} XH^+ + D \\ XD^+ + H \end{cases}$$

where X is He, Ne, Ar, and Kr, were studied in a two-stage mass spectrometer. In these mass transfer reactions, attention was focused on the isotope effect and the XH^+/XD^+ ratio was determined as a function of the kinetic energy of the HD^+ ion in the range from 2 to 20 eV. The ratio curves could be divided into two classes: those for Ar and Kr where the ratio increased monotonically as the energy of the incident ion increased, and those for He and Ne where the ratio had an apparent minimum. The results were interpreted in terms of complex formation and the conservation of energy and angular momentum. A model is proposed for modifying ion molecule reaction theory to account for the phenomenon in HD^+ where the center-of-mass is not at the center of the bond, and the diatomic possesses a rotation about the center-of-mass. This modification produces an energy dependent isotope effect, which correlates well with the experimental data. The charge transfer reaction $X + HD^+ \rightarrow X^+ + HD$ was also observed in the Ar and Kr studies. The results are compatible with Massey's "adiabatic" hypothesis. There are possible indications in the Ar work that vibrationally excited HD^+ molecule-ions are participating in the process. (Disser. Abstr.)

Radiation and Nuclear Chemistry

Refer also to abstract 6587.

6311 (BNWL-SA-1396) INTERACTION OF LOW ENERGY PROTONS WITH THIN LAYERS OF TISSUE-LIKE MATERIAL. Glass, W. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 19, 1967. Contract AT(45-1)-1830. 13p. (CONF-671109-2). Dep. CFSTI.

From Symposium on Microdosimetry, Ispra, Italy.

The ionization resulting from the passage of monoenergetic protons through thin layers of tissue-like gas was investigated. The ions produced by individual protons are collected from a well-defined layer of low density gas and amplified in a proportional counter. The resulting distributions were investigated for layers corresponding to layers of unit density material with thickness between 0.1 and 1.0μ and for proton energies from a few keV to 2 MeV. The maximum value for the mean ionization loss per unit path length was found to depend on the sample thickness, varying from a value of 101 keV/μ for a one micron layer to about 108 keV/μ for a 0.1 micron layer. The measured distributions were compared with distributions calculated by Seltzer and Berger using the energy loss straggling theory due to Vavilov. (auth)

6312 (HMI-B-52) PRODUKTION VON RADIONUKLIDEN AM HAHN-MEITNER-INSTITUT, SEKTOR KERNCHEMIE. (Production of Radionuclides at the Hahn-Meitner-Institute, Sector Nuclear-Chemistry). Reichold, P.; Wolf, P. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). July 1967. 47p. (In German). Dep.

The production of Na-24, K-42, Mg-28, Tc-99m, Os-191, Cu-64, Ag-111, Au-198, Zn-69m/Zn-69, Hg-197m/Hg-197, F-18, Cl-38, and Br-82, and the working up of these nuclides to specialized requirements are reported. Established methods, which were improved or altered for the special needs of the customers and requirements of the Institute, are often used. (auth)

6313 (HMI-B-53) ZEHNTER JAHRESBERICHT (1966) DES SEKTORS KERNCHEMIE MIT KUMULATIVER PUBLIKATIONSLISTE. (Tenth Annual Report (1966) of the Nuclear Chemistry Section With Cumulative Publication List). (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). June 1967. 63p. (In German). Dep.

Research on transport processes of radionuclides in solids is one of the primary areas of work of the Nuclear Chemical Research Section. Other efforts concentrated on reactor chemistry and radioactive wastes, preparation of radioisotopes, dating and activation analysis, and transport processes in solutions and

biological systems. Abstracts of papers on completed studies are included. A chronological cumulative publication list is presented of work originated from the Nuclear Chemical Research Section. (J.S.R.)

6314 (LB/G–2621) RADIATION-INDUCED DEGRADATION OF ALUMINIUM AND MAGNESIUM HYDROXIDES. Glagolev, V. L.; Gordeeva, V. A.; Zhabrova, G. M.; Kadenatsi, B. M. Translated by C. R. Brightmore for Atomic Energy Research Establishment, Harwell, Eng., from Khim. Vys. Energ., 1: No. 3, 285(1967). 3p. Dep. CFSTI. UK. JCL $1.10 fs, $0.80 mf.

A study of the decomposition of $Al(OH)_3$ and $Mg(OH)_2$ under the action of gamma radiation was carried out in air at 20 to 25°C (^{60}Co; 400 R/sec). ESR spectra of the hydroxides irradiated at −196°C were also studied. The samples were first treated in vacuum to remove any absorbed moisture. $Al(OH)_3$ decomposed to a considerable extent at 20 to 25°C ($G_{H_2O} = 1$). The ESR spectra after a dose of 3.1×10^7R showed a broad singlet, and a doublet whose components were 502 ± Oe apart. It was considered that the doublet was due to the presence of stabilized H-atoms. $Mg(OH)_2$ did not show decomposition at doses up to 7×10^5R, and its ESR spectra did not show lines characteristic of stabilized H-atoms. Six approximately equidistant lines appeared to be due to hyperfine interaction of the unpaired electron with the ^{25}Mg nucleons. (UK)

6315 (ORO–3508-3) THE EFFECT OF RADIATION AND GAS CONCENTRATION ON RARE GAS DIFFUSION IN SOLIDS. Annual Progress Report, November 1, 1966–October 31, 1967. Elleman, Thomas S. (North Carolina State Univ., Raleigh. Dept. of Nuclear Engineering). Nov. 1, 1967. Contract AT(40-1)-3508. 28p. Dep. CFSTI.

The effects of radiation damage and gas concentration on rare gas diffusion in solids has been studied by doping single crystals of CsI with ^{133}Xe and studying the time rate of release of the gas during heating. Deviations from classical diffusion were observed which can be attributed to trapping processes occurring within the crystal. Clear single crystals of CsI containing a homogeneous dispersion of ^{133}Xe exhibited classical diffusion while cloudy crystals gave a decreasing diffusion coefficient with time, which is consistent with trapping of gas atoms at naturally occurring defects. Diffusion was also classical for Xe which was recoiled into specimens from an external fissionable source, indicating that there was no enhanced diffusion along the fission recoil track. Radiation damage effects were observed in crystals exposed to higher fission recoil concentrations. Radiation exposure lowered the diffusion coefficient at low temperatures, and annealing of the damage at higher temperatures was reflected in a diffusion coefficient which increased with time. Radiation thus produced trapping of gas atoms in the lattice rather than enhanced diffusion. Release of Xe from uranium doped crystals gave a rapid release (burst) of gas during initial heating which was much more rapid than classical diffusion, followed by classical diffusion at longer heating times. The experimental results are more consistent with an interstitial model for Xe diffusion than with a vacancy model. (auth)

6316 (PRNC–105) RADIOLYSIS OF GASEOUS HYDROGEN HALIDES. Lee, Rupert Archibald (Puerto Rico Nuclear Center, Mayaguez). June 1967. Contract AT(40-1)-1833. 145p. Dep. CFSTI.

Thesis. Submitted to London Univ.

Ion pair yields of 4.1 and 4.7 were measured for the radiolysis of pure gaseous hydrogen chloride and hydrogen bromide, respectively, using ^{60}Co gammas. These yields, together with the W values for HCl (24.8 eV) and HBr (24.4 eV) obtained, lead to calculated G-values of 8.3 and 9.6, respectively, for the two gases. The effect of the scavengers bromine and sulfur hexafluoride on the radiolysis of the two gases revealed that there are at least two hydrogen-forming species present. One of these is a 'thermal' hydrogen atom that may or may not have the electron as its precursor, the other is a 'hot' hydrogen atom that cannot be scavenged. The results with chlorine as scavenger on the HCl radiolysis brought out the importance of back reactions taking place as the concentration of chlorine builds up during the irradiation of pure gaseous hydrogen chloride. A study of the effect of an applied electric field during the radiolysis of the two gases showed that reactions involving the recombination of ions were unimportant as a means of producing hydrogen. This study showed that dissociative excitational processes are as important as ionization processes in the decomposition of these two hydrogen halides. The HBr molecules appear to undergo dissociative excitational processes more readily than the HCl molecules. (auth)

6317 (PRNC–107) STUDY OF RADIATION DAMAGE IN ORGANIC CRYSTALS. Progress Summary Report No. 4. Cobas, Amador; Weisz, Zvi (Puerto Rico Nuclear Center, Rio Piedras). Oct. 1967. Contract AT(40-1)-1833. 25p. Dep. CFSTI.

The effects of gamma radiation in anthracene studied by nonlinear optical methods are described. The dependence of the blue emission under steady red-light excitation is shown as a function of gamma dose. A similar graph for the relative fluorescent yield obtained under near uv excitation is also included. A monotonic decrease in fluorescence efficiency began at a dose rate of about 10^5 R. It was concluded that an individual single crystal of anthracene may permit the determination of γ or x-ray doses over a range from 10^2 to 10^8 R. The low end from 10^2 to 10^4 R can be measured through triplet quenching, the range of 10^3 to 10^5 R by space-charge-limited current technique, the 10^5 to 10^7 R range by singlet quenching, and the high dosage range of 10^7 R and over by direct optical coloration. (M.C.G.)

6318 (JPRS–43250) EXPERIMENTAL METHODS AND CONDITIONS FOR IRRADIATION OF MATERIALS. Konobeevskii, S. T. Translated from pp 44–86 of Deystvie Oblucheniya na Materialy, Atomizdat, Moscow, 1967. 61p. (TT–67-33874). CFSTI.

Methods and conditions for irradiation with neutrons, γ radiation, fission fragments, and accelerated ions are discussed. (54 references). (M.C.G.)

6319 (UCRL-Trans–10148) NEW APPARATUS FOR IRRADIATING LIQUIDS AND GASES WITH ACCELERATED ELECTRONS. Huyskens, P. Translated by Z. F. St-Gallay for Univ. of California, Lawrence Radiation Lab., Livermore, from Ind. Chim. Belge, 30: 693-700(1965). 24p. Dep. CFSTI. JCL $2.60 fs, $0.92 mf.

Work in radiation chemistry aims at reaching high dose rates. An apparatus was built to irradiate liquids and gases continuously with 10- to 100-keV electrons at a rate of about 10^7 RAD/sec. This apparatus permitted the detection of intensity effects in the irradiation of hydrocarbons and aqueous solutions. (auth)

6320 RADIATION DAMAGE TO OPTICAL ABSORPTION PROPERTIES OF ANTHRACENE CRYSTALS. Shiomi, Naoko (Nara Women's Univ., Japan). J. Phys. Soc. Jap., 23: 1177 (Nov. 1967).

Anthracene crystals irradiated at room temperature by ^{60}Co γ rays showed a shoulder in the absorption spectra at 4300 to 5800 Å. This shoulder must be attributed to new stable absorption centers (damaged centers) because the area of the shoulder increases linearly with the absorbed doses. It was concluded that the same sorption centers were produced in doped crystals as in the pure anthracene. (M.C.G.)

6321 PHYSICAL PROPERTIES OF VULCANIZATES FROM POLYMERS PRODUCED BY GAMMA-RADIATION-INDUCED GRAFT POLYMERIZATION OF ACRYLONITRILE TO NR AND SBR. PART III. GAMMA-RADIATION-INDUCED GRAFT POLYMERIZATION OF LATTICES. Tsurugi, Jitsuo (Radiation Center of Osaka Prefecture, Japan); Syobayashi, Goro. Nippon Gomu Kyokaishi, 40: 173-82(Mar. 1967). (In Japanese).

Dielectric properties, i.e., dielectric constant, ϵ', loss factor, ϵ'', and loss tangent, δ, of vulcanizates from polymers produced by γ-induced grafting of acrylonitrile to NR and SBR are reported. Since variations of these properties as function of frequency for the grafted polymers were similar to those of the backbone polymers, it was thought that the former maintained some specific properties of the latter. On the other hand, variations of these properties as function of frequency in the blended polymers depended mainly on the acrylonitrile contents. Determination of dielectric properties also indicated that grafted polymers produced by one procedure had more prominent grafting effect than those by other procedures, and that grafted polymers from SBR had more prominent effect than those from NR. These results agreed with those obtained by determination of mechanical properties of the same vulcanizates reported in previous papers. Dispersion state of the vulcanizates of grafted and blended polymers was also examined under a phase-contrast microscope. (NSA of Japan)

6322 DETERIORATION OF POLYMERS THROUGH IONIZING RADIATION. II. ANTIRADIATION EFFICIENCY OF THE ORGANIC RUBBER CHEMICALS IN NR–OXIME AND NR–PEROXIDE VULCANIZATES. Tsurugi, Jitsuo (Radiation Center of Osaka Prefecture, Japan); Imamura, Kunio. Nippon Gomu Kyokaishi, 40: 388-93(May 1967). (In Japanese).

In developmental studies for antirad, NR–oxime and NR–peroxide vulcanizates containing various kinds of rubber chemcals were irradiated with ^{60}Co γ radiation. Remarkable difference in change of stress at 100% was observed between irradiation in air and that in N_2. Stress at 100% increased more prominently with irradiation in N_2 than with irradiation in air. NR–peroxide vulcanizates containing DPG, OTB, and no antirad were so much deteriorated with irradiation of 1×10^7R, that some physical prop-

erties could not be measured. Stress at 100% of the NR–peroxide vulcanizates containing imidazole and related compounds changed differently from that of ones containing other antirads. The antirads used here were found to be poorly effective. (NSA of Japan)

6323 TERPENOIDS. 10. EFFECTS OF γ RAY RADIATION ON α PINENE. Tomita, Bunichiro; Hirose, Yoshiyuki (Tokyo Univ.). Mokuzai Gakkaishi, 13: 20-3(Feb. 1967).

α-Pinene was irradiated with ^{60}Co γ rays at 1.2 to 1.3 × 10^5 R/hr under aeration at room temperature to the doses of 1.85, 4.40, and 8.08 × 10^7 R, and the ion products were investigated by gas chromatography, and identified by the physical constants, retention time in gas chromatography, and infrared absorption spectrum, and also by simple organic qualitative tests. The compounds identified were substantial amounts of α-campholenic aldehyde(A), pinocarvone(B), pinocarveol(C), myrtenal(D), and verbenone(E), and small amounts of α-pinene epoxide(F) and sobrerol(G). For the radioinduced reactions of α-pinene it was concluded that (B), (C), (D), and (E) are formed from hydroperoxides via free radicals; while (A) and (G) are derived from (F), a secondary product of the reaction between α-pinene and the peracid produced in course of the reaction. (NSA of Japan)

6324 TREATMENT OF WATER BY RADIOACTIVE RADIATION. Sunada, Takeshi (Radiation Center of Osaka Prefecture). Genshiryoku Kogyo, 13: No. 7, 34-7(July 1967). (In Japanese).

A method is described for the radiation treatment of water polluted by chemical substances. Phenol, ABS, parathion, and PMA are dealt with as such pollution substances. The results of ^{60}Co irradiation and of the economic evaluation of this water-treatment technique are presented. The γ dose-rate employed was 500,000 R/hr. For ABS, to reduce it from 20 to to 0.5 ppM, a dose of 500,000 R was required; from 2 ppM to 0.5 ppM, it was 10,000 R. For phenol, the lower the initial concentration, the higher the degree of its reduction. For parathion, 5,000 R reduced 1 ppM by 60% and 10,000 R by 80%. The economic evaluation is made on the basis of the irradiation cost of 5.96 yen per ton of water, for the daily irradiation of 240,000 tons at 200 yen for 1 Ci. The results of the test of the combined irradiation and condensation-precipitation and of the test of irradiation-produced poisonous substances are also described. (NSA of Japan)

6325 DETERIORATION OF POLYMERS THROUGH IONIZING RADIATION. I. ANTIRADIATION EFFICIENCY OF THE ORGANIC RUBBER CHEMICALS IN NR–SULFUR VULCANIZATES. Tsurugi, Jitsuo (Radiation Center of Osaka Prefecture, Japan); Imamura, Kunio. Nippon Gomu Kyokaishi, 40: 382-7 (May 1967). (In Japanese).

As exploratory studies for antirads, NR-sulfur vulcanizates containing various kinds of rubber chemicals, which were considered to be useful for antirads, were irradiated with ^{60}Co γ rays. Comparison of some mechanical properties, i.e., stress at 100%, tensile strength, elongation, and JIS-hardness of the irradiated samples with those of the unirradiated samples was chosen as measure of deterioration by irradiation. Determination of physical properties of vulcanizates with or without an antirad indicated the effectiveness of antirad. The vulcanizates containing no antirad were deteriorated by irradiation from 5 × 10^7 to 1 × 10^8 R. Little difference in changes of stress at 100% was observed between irradiation in air and that in N_2 in the case of vulcanizates containing antirad, but a little difference was observed in the case of vulcanizates containing no antirad. Vulcanizates containing some antirads were a little more resistant than the control, but a clear-cut relationship was not obtained between chemical structure and antiradiation capacity of antirad. (NSA of Japan)

6326 DETERIORATION OF POLYMERS THROUGH IONIZING RADIATION. III. RADIATION CURE OF NR STOCKS CONTAINING VARIOUS KINDS OF VULCANIZING AGENTS. Tsurugi, Jitsuo (Radiation Center of Osaka Prefecture, Japan); Imamura, Kunio. Nippon Gomu Kyokaishi, 40: 394-8(May 1967). (In Japanese).

NR stocks containing various kinds of vulcanizing agents were cured with ^{60}Co γ radiation. Stresses at 100% and 300% were measured to observe the effect of additives on radiation cure. It was found that radiation cure was less effective in the case of stocks with sulfur and sulfur-vulcanizing agents than in the case without them, less effective in the case with GMF than in the case without it, and more effective in the case with Dicup than in the case without it. (NSA of Japan)

6327 EFFECT OF SUBSTITUTED AROMATIC GROUPS ON THE RADIATION STABILITY OF GLYCOSIDES. Sarkar, I. M.; Arthur, J. C. (Dept. of Agriculture, New Orleans). Chem. Ind. (London), No. 49, 2085-7(Dec. 9, 1967).

When solid methyl α-d-glucopyranoside was ^{60}Co γ-irradiated the glycosidic bond was broken, with an initial G (glucose) value of 2.33, but substitution of aromatic groups in the glycoside stabilized the bond. When the benzoyl group was the substituent no glucose could be detected after doses of 4.6 × 10^{21} eV/g. The effects of both electropositive and electronegative substituents in the aromatic rings on the radiation stability of glycosides were also examined. When the compounds were irradiated in the solid state in air at about 25°C, the glycosidic bond was found to be resistant to cleavage, and no reducing power was detectable. Examination techniques included measurement of optical rotation, thin layer chromatography, infrared and NMR spectra. In the case of tosyl esters, however, a new absorption band appeared at 1725 cm^{-1}, indicating a carbonyl group, and it was concluded that in these compounds some cleavage of the glycosidic bond occurred. The presence of substituents on the aromatic ring of substituted glycosides did not significantly affect radiation stability. (UK)

6328 ELEMENTARY PROCESSES OF LOW-TEMPERATURE PHOTOCHEMISTRY AND RADIATION CHEMISTRY. Bagdasar'yan, Kh. S. (Inst. of Physics and Chemistry, Moscow). Kinet. Kataliz, 8: 1073-93(Sept.-Oct. 1967). (In Russian).

A brief review is given on the elementary processes of low-temperature photochemistry and radiation chemistry of organic vitreous liquids in solutions congealed at 77°K. The cations and electrons produced by γ radiation or UV in the glass at 77°K are slowly recombined forming excited molecules. Additional fluorescence spectra and phosphorescence are emitted in the presence of aromatic impurities. The kinetics of recombined luminescence damping at 77°K are described by the low $I_0/I = 1 + kt$ that was identical for the light- and γ-induced radiation. The luminescence can be highly improved by visible light or ir light. Without stimulating radiation the luminescence diminishes according to the first order low with $t_{\frac{1}{2}} \simeq 7$ sec. The latter takes place irrelevant to the method of cation and electron production (either by γ radiation or uv light). (R.V.J.)

6329 ELECTRON PARAMAGNETIC RESONANCE SPECTRA OF IRRADIATED FROZEN AQUEOUS SOLUTIONS. PART 7. AQUEOUS FORMATE SOLUTIONS. Khodzhaev, O. F.; Ershov, B. G.; Pikaev, A. K. (Inst. of Physical Chemistry, Moscow). Izv. Akad. Nauk SSSR, Ser. Khim., No. 10, 2253-60(Oct. 1967). (In Russian).

The free radicals in frozen aqueous formate solutions, irradiated with γ radiation at –196°, were investigated by the EPR method and optical spectroscopy. The trapped electrons (e^-_{cap}) CO_2^-, and H – $C<^{O^-}_{O^-}$ were identified and their formation mechanism is discussed. The optical properties of the trapped electrons and the CO_2^- radicals in the formate "glass" were investigated. It was found that λ_{max} e^-_{cap} in 10 M solutions of HCOONa in H_2O and D_2O occurred at 555 and 535 mμ, respectively (band half width is 0.93 and 0.72 eV), and CO_2^- was characterized by bands with maxima at 250, 270, and 350 mμ (its molar extinction coefficient at 250 mμ is 2.4 × 10^3 l/M · cm). During photoannealing of e^-_{cap} in alkaline "glass," containing $HCOO^-$, CH_2OH, or CO_3^{3-}, diamagnetic centers $(e^-_{cap})_2$ were observed. The latter, as a result of heating to –140°, decays again into e^-_{cap}. (tr-auth)

6330 ELECTROCHEMICAL PROPERTIES OF RADIOACTIVE SPECIMENS OF ZINC AND SILVER. Spitsyn, Vikt. I.; Zimakov, I. E.; Bryantsev, B. I. (Inst. of Physical Chemistry, USSR). Dokl. Acad. Nauk SSSR, 175: 875-8(Aug. 1, 1967). (In Russian).

The electrochemical behavior of radioactive zinc and silver electrodes was studied using specimens of high-purity zinc and silver irradiated by 1.2 × 10^{13} neutron/cm^2 sec. Slow neutrons formed isotopes ^{65}Zn and ^{110m}Ag with $T_{\frac{1}{2}}$ = 250 days and β^+ and γ radiation with maximum E_β = 0.325 MeV and E_γ = 1.12 MeV. The ^{110m}Ag with $T_{\frac{1}{2}}$ = 270 days is a beta irradiator with β^- and γ^- radiation maximums of E_β = 0.53 MeV and E_γ = 1.516 MeV, respectively. It was found that ionizing radiation produced considerable effects on the semiconductor film. The potential of the nonradioactive, oxidized electrode was equal to 802 ± 7mV while specimens with specific radioactivity 25mCi/g was 760 ± 8mV. The curves of electrode potentials of oxidized zinc electrode in 1N $Zn(NO_3)_2$ solution confirmed the postulated influence of irradiation on the oxide film, formed on the metallic zinc and silver surfaces. The discharge curves of galvanized pair Zn-oxidized silver electrode showed that the discharge of radioactive pairs considerably increased and continued to increase the higher the total radioactivity of both electrodes. The results obtained indicated that the radioactive emission of zinc and silver do not influence the potential of metallic electrodes but change the magnitude of potentially oxidized metals. (R.V.J.)

6331 DETERMINATION OF MEAN ENERGY OF ION FORMATION IN ETHYLENE AND ACETYLENE IRRADIATED BY ^{137}Cs GAMMA RADIATION. Bregadze, Yu. I.; Vasil'eva, O. I.;

Isaev, B. M.; Tultaev, A. V. Izmer. Tekh., No. 8, 68-70(Aug. 1967). (In Russian).

The value of the mean energy of ion formation in ethylene and acetylene was determined. The results of the thermal measurement of the absorbed dose of ^{137}Cs γ radiation in polyethylene and polystyrene were compared with the results of ionization current measurements in homogeneous chambers of these materials. The values obtained agree with the literature data within the limits of experimental error. (tr-auth)

6332 STUDIES ON AZULENES. II. THE ACTION OF RADIATION ON AZULENES. GAMMA-IRRADIATION OF GUAIAZULENE. Otani, Yasushi; Hirayama, Hiroshi. (Konan Kako Co., Ltd. Kinki Univ., Japan). Yakugaku Zasshi, 87: 894-7 (Aug. 1967). (In Japanese).

Guaiazulene was irradiated with γ rays at a constant dose rate and its absorption spectrum compared with spectra of the compound irradiated at different dose rates. There were almost no changes with changing in dose rates, and the absorption intensity tended to decrease with increasing irradiation dose. Irradiation of a solution at concentrations of 10^{-1}, 10^{-2}, and 10^{-3} M at the same dose level indicated that a dilute solution is more liable to be affected. A 10^{-2} M solution was irradiated with 10^{7} and 10^{8} R, the solution was evaporated, and the sample was submitted to elemental analysis. Analytical values suggested that guaiazulene was reduced and the product did not form a crystalline addition compound with picric acid or 1,3,5-trinitrobenzene. In the infrared spectra, the peaks at 1562 and 1532 cm^{-1}, which are considered to indicate the azulene skeleton, were absent in the spectrum of the irradiated sample, in which a new peak appeared at 1698 cm^{-1}. (NSA of Japan)

6333 HIGH-PRESSURE TECHNIQUE AND SAFETY MEASURES IN THE RADIATION POLYMERIZATION OF ETHYLENE. Sawayanagi, Shoichi; Machi, Sueo (Japan Atomic Energy Research Inst.). Koatsu Gasu, 3: No. 3, 6-13(Sept. 1966). (In Japanese).

A historical review is given of research on the radiation polymerization of ethylene. Brief explanations are made of the mechanism of radiation polymerization and thermodynamics of high-pressure ethylene, including the relation between the pressure and fugacity of ethylene and between the polymerization velocity and the average molecular weight of the polymers, the effect of pressure on the initation reaction, the effect of pressure on the propagation reaction, and the effect of pressure on the branching reaction. The polymerization rate per passage of the monomer is below 10%; and the reaction vessel is irradiated from outside with the average dose rate of 3.7×10^{5} R/hr. The reaction pressure is maximum 410 kg/cm^2 and the reaction temperatures are from room temperature to 100°C. The process flow for the reaction is described along with the deoxygenizer, dehumidifier, compressor and circulation pumps, reaction vessel, separator, and filter. The pressure, monomer flowrate, and temperature are controlled automatically, and a level gage operating on the difference in dielectric constants of the monomer and polymer is installed in the storage vessel of polymer. Special cautions are taken to prevent the leakage of monomer gas from the high-pressure reaction system. (NSA of Japan)

6334 EFFECT OF IONIZING RADIATIONS ON POLYUNSATURATED FATTY ACIDS. Dhopeshwarkar, G. A.; Atmaram, Ratna H. (Atomic Energy Establishment, Trombay, India. Tata Memorial Hospital, Bombay). Indian J. Technol., 5: 227-30 (July 1967).

The effects of ^{60}Co gamma radiation on the polyunsaturated fatty acids of prawns (particularly rich in these acids) were studied. There was considerable reduction in the contents of eicosatetraenoic, eicosapentaenoic, and docosahexaenoic acids when the samples were irradiated at room temperature. When they were irradiated in the frozen condition, no significant change was observed in the content of any of the acids. Thus radiopasteurization under frozen conditions offers an added advantage by preserving nutritionally essential polyunsaturated fatty acids. (auth)

6335 RADIOLYTIC HYDROGEN YIELD FROM SOLUTIONS OF CHLORO-SUBSTITUTED ETHYLENES IN CYCLOHEXANE. Horowitz, A.; Rajbenbach, L. A. (Soreq Nuclear Research Centre, Yavne, Israel). Chem. Commun., No. 23, 1234(1967).

The presence of olefins, even in dilute concentrations, is known to reduce considerably hydrogen yields from the radiolysis of saturated hydrocarbons and, to account for this, chemical reactions involving H-atom scavenging, and physical interactions such as charge or energy transfer, were invoked. A study is reported on the effect of several chloroethylenes on the radiolytic hydrogen yield from cyclohexane, with a view to illustrating the importance of physical interactions in the reduction of hydrogen yield. The chloroethylenes employed were cis-1,2-dichloro-, trichloro- and tetrachloro-compounds, and ^{60}Co gamma irradiation was used at room temperature. It was demonstrated that the decrease in hydrogen yield became more pronounced with progressive substitution by Cl atoms. It was suggested that reduction in hydrogen yield from cyclohexane by ethylene is due to H-atom scavenging, and it would be expected that the chloro-substituted ethylenes would be less effective as scavengers, allowing higher hydrogen yields. The opposite effect was found, and it was concluded that such scavenging does not constitute a major effect. The ionization potentials of the chloroethylenes are very much the same, and the occurrence of charge transfer processes would not account for the more pronounced decrease in hydrogen yield in the presence of higher chloro-substituted compounds. The electron affinity, however, might well rise with increasing Cl content, and electron scavenging processes are consistent with experimental findings. (UK)

6336 CARBON DEPOSITION FROM IRRADIATED METHANE. Blake, A. R. (Electricity Council Research Centre, Capenhurst, Eng.); Hilton, D. A.; Robins, I. H. J. Appl. Chem. (London), 17: 321-4(Nov. 1967).

Carbon-14 tracer techniques were used to measure directly the carbon deposition resulting from radiolysis of methane by itself and in the presence of carbon dioxide, oxygen and graphite. It was shown that carbon deposition is increased in the presence of carbon dioxide and decreased in the presence of oxygen. At high carbon dioxide pressures (40 cm Hg) and high doses (>100 MRAD) most of the methane was decomposed to deposit. Irradiation of methane by itself produced less deposit than in the presence of graphite. The results of the analyses for light hydrocarbons produced during methane radiolysis over a range of conditions are also briefly discussed. (auth) (UK)

6337 RECENT DEVELOPMENTS IN THE MECHANISM OF THE PROTECTION EFFECT OF AROMATIC COMPOUNDS ON THE RADIOLYSIS OF ALIPHATICS. Ekstrom, A.; Garnett, J. L. (Univ. of New South Wales, Sydney). J. Label. Compounds, 3: 167-83(July-Sept. 1967).

The proposed mechanisms by which aromatic compounds protect aliphatic materials from enhanced radiolytic decomposition are reviewed. Recent developments in this field using the radiolysis of methanol–benzene as a typical system are discussed. Emphasis was placed on the identification and isolation of scavenging products from methanol–benzene also the chemical fate of the added benzene. Isotope effects were used to elucidate possible mechanisms of formation of the scavenging products. The application of the results of this study to the problem of self-destruction of radioactive compounds is discussed. An interpretation of the mechanism of the protection effect in terms of the storage of labeled molecules is made. (auth)

6338 DETERMINATION OF RARE GAS DIFFUSION FOLLOWING RECOIL LABELLING OF PLANE OR SPHERICAL SOLIDS. Di Cola, G. (CCR-EURATOM, Ispra, Italy); Matzke, Hj. Nucl. Instrum. Methods, 57: 341-5(Dec. 1967).

Rare gas diffusion is usually determined following homogeneous labelling of the solid using a nuclear reaction and reactor irradiation or ion bombardment with vertical incidence of the beam. Frequently, however, these methods cannot be used as either no suitable nuclear reaction exists in the substance to be studied, an ion accelerator is not available, or the substance is only available in the form of powder. In these cases, recoil processes can be used to introduce the gas into the solid: following adsorption of a thin layer of ^{226}Ra on the solid, the daughter product ^{222}Rn is recoiled into the sample with an energy of about 85 keV. Alternatively, the fission rare gases Kr and Xe can be introduced into any solid with a recoil energy of about 80 MeV by reactor irradiating the solid in contact with a uranium bearing matrix. The mathematical solutions are presented of the diffusion equation needed for evaluating gas release curves from such samples for the two most important geometrical shapes of a slab (infinite plane sheet) and for powdered samples (assuming spherical shape of the particles). Some experimental data are shown to demonstrate agreement between theory and experiment. (auth)

6339 THE CHEMICAL EFFECTS OF γ-RADIATION ON ORGANIC SYSTEMS. PART XIII. THE SYSTEM DIETHYLAMINE–IODOBENZENE. Cunanan, S. A.; Swan, G. A. (Univ. of Newcastle-upon-Tyne, Eng.). J. Chem. Soc. (C), No. 22, 2311-12(1967).

The products of γ-radiolysis of a mixture of diethylamine and iodobenzene were found to include NN-diethylaniline, 1-phenyldiethylamine, and traces of indole derivatives. (auth) (UK)

6340 RADIOINDUCED ADDITION OF MERCAPTANS TO VINYL COMPOUNDS. Sawada, Shuzo; Yamamoto, Masaharu (Nagoya Univ., Japan). Kogyo Kagaku Zasshi, 69: 1964-7(Oct. 1966). (In Japanese).

The γ-induced addition of mercaptans to various vinyl compounds

was studied both in the liquid and in the solid state. The reaction products were exclusively 1:1 adducts of a mercaptan and a monomer. G-values for the production of these adducts at 25°C were of the order of 10^4 in most cases, and various radical scavengers inhibited the reaction. These results indicate the radical chain reaction mechanism. In the case of ethyl mercaptan and vinyl acetate, the addition reaction took place even in the solid state (77°K), and it was observed that the yield became saturated with increasing dose. The apparent activation energies in the liquid and solid states were 0.5 and 0 kcal/mol, respectively. The yield of 1:1 adducts depended on the composition of the mixture and the position of the maximum varied with the temperatures and with the kind of mercaptans and monomers. In most cases, the rate of the reaction was proportional to the dose rate. Reactivity ratios of the reaction of ethyl mercaptan with various monomers were obtained. (NSA of Japan)

6341 IRRADIATION OF POLYMERS. A Symposium, 151st Meeting of the American Chemical Society, Pittsburgh, Pa., March 29–30, 1966. Advances in Chemistry Series No. 66. American Chemical Society Publications. Washington, D. C., American Chemical Society, 1967. 286p. (CONF-660320).

Separate abstracts were prepared for 13 of the 18 papers. The remaining papers were previously abstracted for NSA and appeared as abstracts 20: 43370, 43372, 43374, 43376, and 43378. (M.C.G.)

For abstracts of individual papers see: 6296 and 6342–6353.

6342 RADIATION MECHANISMS IN POLYMERS. Charlesby, Arthur (Royal Military College of Science, Shrivenham, Eng.). Advan. Chem. Ser., No. 66, 1-21(1967).

From American Chemical Society, 151st Meeting, Pittsburgh, Mar. 22–31, 1966. See CONF-660320.

Investigating polymers irradiated under various conditions provides information on many of the processes occurring between initial energy absorption and final physical and chemical change. Among factors that can modify these reactions are the type of radiation, presence of oxygen and of additives, degree of crystallinity, and presence of solvent. Reactions may also be affected by nonlocalization of absorbed energy, energy transfer, electron trapping and recapture, and abstraction by high- and low-energy hydrogen atoms. Several new techniques are available to study these intermediate states. Radiation treatment of polymers can be used to investigate crystal morphology, reinforcement, and electrical properties. Many of these results are applicable to radiobiology. (auth)

6343 REACTIVE INTERMEDIATES IN THE RADIATION CHEMISTRY OF POLYETHYLENE. Dole, Malcolm (Northwestern Univ., Evanston, Ill.); Bodily, David M. Advan. Chem. Ser., No. 66, 31-43(1967).

From American Chemical Society, 151st Meeting, Pittsburgh, Mar. 22–31, 1966. See CONF-660320.

The types and reactions postulated for reactive intermediates in the radiation chemistry of polyethylene are reviewed. Ultraviolet spectroscopy is an important tool in complementing data obtained from electron spin resonance studies. Finally, the kinetics of growth and decay of the allyl and polyenyl free radicals as inferred from ultraviolet spectra are discussed. (auth)

6344 IRRADIATION OF HYDROCARBON POLYMERS IN NITROUS OXIDE ATMOSPHERE. Okada, Yoichi (Sumitomo Bakelite Co., Ltd., Yokohama, Japan). Advan. Chem. Ser., No. 66, 44-56(1967).

From American Chemical Society, 151st Meeting, Pittsburgh, Mar. 22–31, 1966. See CONF-660320.

Polyethylene, polypropylene, and polyisobutylene were irradiated by γ rays from a ^{60}Co source in an atmosphere of nitrous oxide (N_2O). Polyethylene and polypropylene irradiated in N_2O give a higher yield of crosslinks than when irradiated in vacuo. On the other hand, nitrous oxide reduced the amount of radiation degradation of polyisobutylene. The effect of nitrous oxide on the three polymers increased monotonically with the gas pressure in an irradiation ampoule. The disappearance of nitrous oxide and the formation of water and nitrogen indicated a dehydrogenation process from the hydrocarbon polymer chains. $G(-N_2O)$ is on the order of 10^3. This large value suggests energy transfer. (auth)

6345 EFFECTS OF RADIATION ON THE OLEFINIC GROUPS IN POLYBUTADIENE. Parkinson, W. W. (Oak Ridge National Lab., Tenn.); Sears, W. C. Contract W-7405-eng-26. Advan. Chem. Ser., No. 66, 57-70(1967). (ORNL-P-2450).

From American Chemical Society, 151st Meeting, Pittsburgh, Mar. 22–31, 1966. See CONF-660320.

Olefinic groups, present in high concentration in polybutadiene, change rapidly when exposed to ionizing radiation. Concentration changes of olefinic groups in four polybutadienes resulting from gamma and reactor irradiation were measured by infrared absorption spectra. The four types, irradiated in vacuum as x-ray-cured thin films were 92% cis-1,4, crystalline 95% trans-1,4, amorphous 73% trans-1,4, and an amorphous 71% side vinyl 1,2 polymer. The cis-vinylene groups were destroyed at a rate (G value) of ~15 groups per 100 eV, with the rate of conversion to the trans isomer proceeding at (G value) approximately 7. The trans-vinylene and side vinyl groups were destroyed in the polymers containing appreciable concentrations of them in apparent first-order processes. Their high reaction rates indicate efficient energy or charge transfer to the olefinic groups or possibly chain reactions. (auth)

6346 TRANSIENT ACCELERATION OF CREEP RATES OF POLYMERS DURING HIGH INTENSITY IRRADIATION. Bell, James P.; Michaels, Alan S.; Hoffman, Allan S.; Mason, Edward A. (Massachusetts Inst. of Tech., Cambridge). Advan. Chem. Ser., No. 66, 79-112(1967).

From American Chemical Society, 151st Meeting, Pittsburgh, Mar. 22–31, 1966. See CONF-660320.

Creep rates of three glassy polymers were much greater during electron irradiation than before or after. Radiation heating was eliminated as a possible cause. Essentially the same concentration of unpaired electrons and ratio of cross-linking to scission were found in polystyrene samples in the presence or absence of stress. The effects of radiation intensity, stress, and temperature on creep during irradiation were examined. Accelerated creep under stress was directly related to a radioinduced expansion in the absence of stress. This radiation expansion is decreased by an increase in temperature or plasticizer content and decrease in sample thickness. It was concluded that gas accumulation within the sample during irradiation causes both expansion under no stress and acceleration of creep under stress. (auth)

6347 RADIATION MODIFICATION OF POLY(ETHYLENE OXIDE). King, P. A. (Union Carbide Corp., Tuxedo, N. Y.). Advan. Chem. Ser., No. 66, 113-26(1967).

From American Chemical Society, 151st Meeting, Pittsburgh, Mar. 22–31, 1966. See CONF-660320.

Electron or gamma irradiation of high-molecular-weight poly(ethylene oxide) (Polyox) caused marked changes in solution properties, molecular-weight distribution, and molecular weight. Crosslinking and degradation both occurred, but their relative importance was determined by experimental conditions such as dose rate, oxygen concentration, and particle size. At low dose rates and in the presence of air, the G (scission) value was about 200. Changes in molecular weight and molecular-weight distribution were measured and related to gross improvements observed in solution properties: lower viscosity, increased shear stability, and longer shelf life. (auth)

6348 RADIATION CROSSLINKED IONOMERS AND POLYETHYLENES. Lyons, B. J.; Vaughn, C. R. (Raychem Corp., Redwood City, Calif.). Advan. Chem. Ser., No. 66, 139-54(1967).

From American Chemical Society, 151st Meeting, Pittsburgh, Mar. 22–31, 1966. See CONF-660320.

The effects of ionizing radiation on a low- and a high-density polyethylene and an ionomer indicate that similar networks are formed in the ionomer and in the low density polyethylene. The former crosslinks about 1.5 times as readily as the latter. In the high-density resin, the network characteristics, and hence, presumably, the type and distribution of links, differ considerably from those in the other two resins. As a result, crosslinking rates in the high- and low-density polyethylenes cannot be directly compared. (auth)

6349 RADIATION CROSSLINKING OF SOME NEW ETHYLENE COPOLYMERS. Vermes, Rudolph (Allied Chemical Corp., Morristown, N. J.); Brenner, Walter. Advan. Chem. Ser., No. 66, 156-69(1967).

From American Chemical Society, 151st Meeting, Pittsburgh, Mar. 22–31, 1966. See CONF-660320.

Electron beam-initiated crosslinking at ambient temperatures in the presence of air is a convenient way to upgrade the thermal stability of new polymeric materials and improve their physical and chemical properties. Response of irradiation-crosslinked ionomers, ethylene–vinyl acetate and ethylene–butadiene copolymers, to ionizing radiation dosages was different from that of low-density polyethylene. In general, mechanical properties reached a maximum at a given total ionizing radiation dosage and begin to decline upon further exposure. Thermal stability and chemical resistance improve significantly after exposure to dosages on the order of 5 to 10 megarads or more. (auth)

6350 RADIATION-INDUCED POLYMERIZATION OF PURE LIQUID α-METHYLSTYRENE. Metz, Donald J. (Brookhaven National Lab., Upton, N. Y.). Advan. Chem. Ser., No. 66, 170-83 (1967).

From American Chemical Society, 151st Meeting, Pittsburgh, Mar. 21–31, 1966. See CONF-660320.

A method for preparing α-methylstyrene to investigate its radioinduced polymerization yields samples that exhibit reproducible kinetics. The kinetic results are interpreted as indicating that free radicals, carbonium ions, and carbanions can all propagate simultaneously, the relative importance of each species depending on the dryness of the monomer and all associated glassware. This viewpoint is further supported by data from a preliminary investigation of the transients formed in α-methylstyrene, as studied by the pulse radiolysis technique. (auth)

6351 RADIATION-INDUCED GRAFT POLYMERIZATION OF FLEXIBLE POLYURETHANE FOAM. Skraba, Walter J. (Union Carbide Corp., Tuxedo, N. Y.); Lynn, John W. Advan. Chem. Ser., No. 66, 214-20(1967).

From American Chemical Society, 151st Meeting, Pittsburgh, Mar. 22–31, 1966. See CONF-660320.

Flexible polyurethane foam pre-irradiated with ionizing radiation in the presence of air can be readily grafted with vinyl monomers. Relatively low radiation doses (3 to 10 megarads) are required to graft various polar vinyl monomers. Grafting of as little as 2% by weight of acrylamide, methacrylamide, or acrylic acid converts the normally hydrophobic polyurethane foam into a water-wettable sponge. (auth)

6352 RADIATION GRAFTING OF VINYL MONOMERS TO WOOL. Campbell, Daniel; Williams, J. L.; Stannett, Vivian (Research Triangle Inst., Durham, N. C.). Advan. Chem. Ser., No. 66, 221-39(1967).

From American Chemical Society, 151st Meeting, Pittsburgh, Mar. 22–31, 1966. See CONF-660320.

Further details of the mutual radiation grafting of styrene to wool were elucidated. Substantial grafting takes place in air. Mainly postirradiation effects were found with machine irradiation. The grafting was diffusion controlled, and the grafted side chains and in situ homopolymer have molecular weights between 25,000 and 100,000, believed to be caused by chain transfer. A brief discussion of grafting kinetics is presented. ESR spectroscopy was used to determine second-order radical decay constants as 0.03, 1.9, and 4.8×10^{-22} radical^{-1} gram seconds^{-1} for the dry wool, 10% methanol, and 18% methanol–monomer solutions, respectively. The G(radical) values were found to be 0.8 for dry wool and 0.4 for the monomer solutions after correcting for the different decay rates. (auth)

6353 FREE RADICALS IN POLYOLEFINS INITIATED WITH ULTRAVIOLET AND IONIZING RADIATION. Ranby, Bengt; Carstensen, Peter (Royal Inst. of Tech., Stockholm). Advan. Chem. Ser., No. 66, 256-70(1967).

From American Chemical Society, 151st Meeting, Pittsburgh, Mar. 22–31, 1966. See CONF-660320.

Radical structures formed by high-energy radiation and ultraviolet light in some bulk polyolefins are compared. Polyethylene, polypropylene, polyisobutylene, poly(1-butene), and poly(4-methyl-1-pentene) were all studied by the ESR technique after irradiation in vacuo with ionizing radiation and ultraviolet light, respectively. There are essential differences between the two types of radical-producing irradiations. After ultraviolet irradiation chain scission radicals and small fragments such as methyl and ethyl radicals are observed, while in the case of high-energy radiation, no C–C bond scission radicals have been positively detected. Based on energy considerations, the probable reasons for these differences are discussed. (auth)

6354 THERMOPLASTIC COMPOSITION. Chameroy, Jean Gustave (to Groupement Atomique Alsacienne Atlantique). British Patent 1,093,979. Dec. 6, 1967. Priority date Jan. 5, 1965, France.

A thermoplastic material having a response equivalent to that of organic tissues with respect to β, γ, and x radiations and fast neutrons, consisting of (by weight) 55 to 70% polypropylene or polyethylene, 15 to 25% polyoxymethylene, and 15 to 20% aluminum oxide was prepared. The material may be used in the manufacture of radiation monitors for measuring the dose of nuclear radiations absorbed into tissues, the energy absorbed by the monitor or detector and that absorbed into the tissues having a constant ratio, independent of the radiation energy in a very broad energy spectrum. (D.H.M.)

6355 METHOD FOR COPOLYMERIZING KETENE AND FORMALDEHYDE WITH IONIZING RADIATION Okamura, Seizo (to Japan Assoc. Radiation Res. Polymers). Japanese Patent 1966-17674. Oct. 7, 1966. Filed Mar. 9, 1963.

The copolymer produced has high durability and is capable of possessing a variety of properties by suitable compositions of both ketene and formaldehyde. A mixture of suitable composition is irradiated with ionizing radiation at low temperatures, with or without a solvent. (NSA of Japan)

6356 METHOD FOR POLYMERIZING TETRAFLUOROETHYLENE. Yonetani, Yuzuru (to Daikin Kogyo Co., Ltd.). Japanese Patent 1966-16194. Sept. 12, 1966. Filed Feb. 12, 1963.

In a conventional method, tetrafluoroethylene is polymerized by use of a catalyst or other additives; but the drawback is then the difficulty in removing the catalyst from the product polymer. In the other method, using a radiation, drawbacks are the large distribution of molecular weights and hence an ununiform product and inferior mechanical and electrical properties. In the proposed method, these drawbacks are largely eliminated. Gaseous tetrafluoroethylene, kept at a constant temperature between −50 and 250°C, is irradiated with high-energy, ionizing radiation at 1×10^2 to 5×10^6 R/hr to a total dose of 5×10 to 1×10^4. The product is uniform polytetrafluoroethylene in the form of fine particles, with a small distribution of molecular weights, a molecular weight of over 6,000,000, a wet sieve size of 50 to 500 μ, and an anisotropic expansion coefficient of 1.14 to 1.25. (NSA of Japan)

6357 AQUEOUS RADIATION CHEMISTRY OF CYSTEINE AND SOME RELATED COMPOUNDS. Samahy, Ahmad Abd Allah El. Newark, Del., Univ. of Delaware, 1964. 161p.

Thesis.

The aqueous radiation chemistry of cysteine and related compounds was correlated with and interpreted in terms of the modern concepts of aqueous radiation chemistry. Kinetic competition studies were carried out in order to help in providing the mechanism of the in vitro radiolysis with the ^{60}Co γ source. At initial concentrations of cysteine, $(RSH)_0$, lower than 10^{-3}M, secondary reactions were very important after 1000 RAD. Therefore, radiolytic yields were reported only for initial slopes and given as G values. G(–RSH) was followed polarographically and found to be sensitive to pH and the $(RSH)_0$. The primary products, which were identified, were H_2, H_2S, and cystine. These products were determined by the Van Slyke technique, colorimetrically, and polarographically, respectively. Ammonia was found to be a secondary product and there was no indication of production of S in the case of the oxygen-free system. In acidic solution G(–RSH) varied from 4 to 11 in the concentration range 2×10^{-4}M to 4×10^{-3}M and then decreased to a value 9 at 6×10^{-3}M $(RSH)_0$. $G(H_2S)$ was found to be almost concentration-independent and had a value of about 1.2. In neutral solution the yields of H_2S, RSSR, and rate of disappearance of RSH were measured as a function of $(RSH)_0$. Again G(–RSH) was quite dependent on $(RSH)_0$ and varied from 8 to 20 in the concentration range of 10^{-4}M to 5×10^{-3}M. At concentration 6×10^{-4} M $(RSH)_0$, there was strong evidence that $G(H_2S)$ of about 2.75 arises from 2 sources: part from $RSH + H \rightarrow R + H_2S$ and the majority of H_2S comes from a reaction of e^-_{aq} with cysteine probably $e^-_{aq} + RSH \rightarrow R + SH^-$. The competition between P-nitrosodimethylaniline and cysteine showed that cysteine is an efficient OH radical scavenger. The bimolecular constant for scavenging is nearly diffusion-controlled. Similar results obtained from competition with isopropanol show that cysteine is a fairly good H atom scavenger. In separate competition studies with added nitrate and acetone (which are reported as efficient e^-_{aq} scavengers), both reduced $G(H_2S)$ to a low value. With added acetone the limiting value of $G(H_2S)$ is about 0.3 which is about half the value of G H at neutral pH. This yield might be expected from partitioning of the residual H atoms on reacting with cysteine forming H_2S and RSSR. Added nitrate lowered $G(H_2S)$ to nearly zero as would be expected if the nitrate acted as e^-_{aq} and H atoms scavenger. From these competition studies relative rate constants are obtained $K(e^-_{aq} + RSH)/K(e^-_{aq} + CH_3COCH_3) = 0.9$ and $K(e^-_{aq} + RSH)/K(e^-_{aq} + NO_3^-) = 0.4$. A few exploratory experiments on the radiolysis of air-saturated cysteine solutions at pH 1 showed that G(–RSH) varies from 6 to 28 in the concentration range 2×10^{-4}M to 5.4×10^{-3}M (RSH) and G(–RSH) was also dependent upon radiation intensity. The radiolysis of o-aminothiophenol hydrochloride, 3-amino-1-propanethiol hydrochloride, and 4-amino-2-methyl-2-pentanethiol hydrochloride was studied. It would appear from these preliminary results that with one exception the –SH compounds studied may all be OH radical, e^-_{aq} and H atom scavengers. Some assumptions are made showing that the scavenging ability of these compounds could have some importance in the mechanism where these compounds protect biological systems. (Disser. Abstr.)

6358 PROCESS FOR THE PRODUCTION OF COPOLYMER OF TETRAFLUOROETHYLENE AND ETHYLENE. (to Kogyo Kaihatsu Kenkyusho). British Patent 1,092,739. Nov. 29, 1967. Priority date May 29, 1965, Japan.

A process for the production of a copolymer of tetrafluoroethylene and ethylene is characterized by the adding a fluorochlorohydrocarbon to the mixture of the two components to be polymerized and subjecting the mixture to ionizing radiation at

a dose rate of 10^{10} to 10^{2} R/hr at a temperature below room temperature. (B.L.M.)

6359 METHOD FOR PREVENTING STATIC ELECTRICITY ON THE SURFACE OF A SOLID HIGH-POLYMER MATERIAL BY IRRADIATION WITH ACCELERATED NUCLEAR PARTICLES OR NUCLEAR-DECAY RADIATIONS. Suga, Yoshio (to Inst. Phys. and Chem. Res.). Japanese Patent 1966-12514. July 15, 1966. Filed Oct. 6, 1956.

A method of eliminating static electricity on the surface of high polymer articles consists of painting the surface with an oil or high-grade alcohol. By this method adhesion of static electricity can be prevented by a simple "physical" treatment, without changing the external appearance of high-polymer products. The high-polymer material is then irradiated with accelerated nuclear particles or decay radiation, in a dosage equivalent to the order of a unit dose of deuterons, and thus a thin layer for preventing static electricity is formed on the surface. (NSA of Japan)

6360 METHOD OF BLEACHING, USING RADIOACTIVE R`DIATION. Asai, Takuo. Japanese Patent 1967-1783. Jan. 27, 1967. Filed Mar. 17, 1964.

A method is proposed to yield good-quality bleaching at low cost by irradiation of the fibrous material that has been dipped in an aqueous solution of a good bleaching agent. (NSA of Japan)

Radiochemistry

Refer also to abstracts 6618 and 7746.

6361 (AERE-R-5547) A CATALOGUE OF 30-MeV GAMMA ACTIVATION PRODUCTS. PART I. SODIUM TO MOLYBDENUM. Baker, C. A.; Hunter, G. J.; Wood, D. A. (Atomic Energy Research Establishment, Harwell (England)). Sept. 1967. 46p. Dep. CFSTI. UK 7s. 0d.

The elements Na to Mb were irradiated with 30-MeV gamma photons under specified irradiation conditions. Gamma spectra of the active products are presented, together with values for the specific activities, methods of identification of the nuclides present, and the nuclear reactions by which the products were formed. (auth) (UK)

6362 (ANL-Trans-537) β-DECAY PROCESSES OF ^{131}I AS A METHOD FOR THE PREPARATION OF ONIUM DERIVATIVES OF XENON. Nefedov, V. D.; Toropova, M. A.; Levchenko, A. V. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Radiokhimiya, 9: 138-9(1967). 6p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

Synthesis of organic derivatives of xenon by β decay of ^{131}I is described. The possibility of a formation of phenylxenonium cations and of the corresponding derivatives during the β decay of ^{131}I in diphenyliodonium perchlorate was investigated. Results from experiments on the accumulation of decay products in aqueous solutions of $(C_6H_5)_2{}^{131}ICIO_4$ showed that all the xenon formed was present in a free state. In 10% $HClO_4$ solutions approximately 40% of ^{131m}Xe was in a chemically bound state. (M.C.G.)

6363 HISTORY OF THE SYNTHETIC ACTINIDE ELEMENTS. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.). Actinides Rev., 1: No. 1, 3-38(Sept., 1967).

Production and separation techniques used in the discovery of the synthetic actinide series ($93 \leq Z \leq 103$) are reviewed. The review also mentions the investigators involved with the discovery of these elements and their particular contributions. The future outlook of research on these elements and their isotopes is examined. (B.G.D.)

Separation Processes

Refer also to abstracts 6940, 6942, and 7983.

6364 (AERE-R-5074) THE SEPARATION OF ^{238}Pu FROM IRRADIATED ^{237}Np AND FROM FISSION PRODUCTS. PART 1. PRELIMINARY WORK. PART 2. PROCESSING RUNS. Jenkins, I. L.; Shorthill, C. G. C.; Streeton, R. J. W.; Wain, A. G. (Atomic Energy Research Establishment, Harwell (England)). May 1966. 48p. Dep. CFSTI.

Preliminary work leading to the adoption of an anion-exchange process for the separation of ^{238}Pu from ^{237}Np and from fission products is described. An outline of the ion-exchange process is given and decontamination factors for ruthenium and zirconium/niobium were measured. (auth)

6365 (ANL-7362) ENGINEERING DEVELOPMENT OF FLUID-BED FLUORIDE VOLATILITY PROCESSES. PART 12. EXPLORATORY TESTS ON FLUORINATION OF URANIUM OXIDE WITH BrF_5 IN A BENCH-SCALE FLUID-BED REACTOR SYSTEM. Gabor, J. D.; Ramaswami, D. (Argonne National Lab., Ill.). Aug. 1967. Contract W-31-109-eng-38. 18p. Dep. CFSTI.

Through the use of BrF_5, uranium and plutonium can be separated in a single fluorination step. BrF_5 selectively fluorinates uranium from UO_2 fuels as the volatile UF_6 while converting plutonium oxide to nonvolatile PuF_4. A series of 21 exploratory runs on the development of a BrF_5 fluorination process was conducted with a $1\frac{1}{2}$-in.-dia fluid-bed reactor. These runs were made with UO_2 pellets (no plutonium). For each run, except for the tests to determine the feasibility of direct fluorination of UO_2, the UO_2 pellets were pulverized to U_3O_8 by oxidation before being fluorinated with BrF_5. The lowest fluorination temperature with BrF_5 for practical operation was found to be 200°C. The rate of fluorination increased with the concentration of BrF_5 in the range of 10 to 50 vol % BrF_5 in nitrogen. Direct fluorination of UO_2 pellets with a mixture of 10 to 20 vol % BrF_5 and 30 vol % oxygen in nitrogen at 300 to 400°C essentially does not proceed. A small concentration of BrF_5 (1 to 2 vol %) acts as a promoter for fluorination of U_3O_8 with elemental fluorine at low temperatures (~200°C). A 3-hr run, consisting of alternate oxidations and fluorinations, resulted in a slight increase in oxidation of UO_2 to U_3O_8 fines and a slight decrease in the fluorination of the U_3O_8 to UF_6 in comparison to another 3-hr run consisting of 1 hr oxidation followed by 2 hr of fluorination. The fluorination with BrF_5 proceeded smoothly in a fluid-bed reactor. No bed caking was observed in any of the runs. (auth)

6366 (EUR-3625f) INSTALLATION PILOTE DE TRAITEMENT D'EFFLUENTS POUR LA RECUPERATION DU CAESIUM 137. PROJET BUTO. (Pilot Waste Processing Plant for the Recovery of ^{137}Cs. Project BUTO). Fradin, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Oct. 1967. Contract 025-62-10 RISF. 114p. (In French). Dep. CFSTI.

A pilot appliance capable of ion-exchange separation of cesium-137 from acid waste is being planned. By means of this plant, the salient features of which are its simplicity and versatility, it is possible to study new mineral exchangers and to carry out any ion-exchange operation affecting radioactive waste. A description of the plant, the chemical equipment, and the actuation, measuring, regulatory, and control devices are described. (auth)

6367 (IS-T-188) EXTRACTION OF SOME HEAVIER RARE EARTHS IN ACIDIC CHLORIDE SOLUTION BY DI(2-ETHYLHEXYL) PHOSPHORIC ACID. Owens, Thomas Charles (Ames Lab., Iowa). Nov. 1967. Contract W-7405-eng-82. 81p. Dep. CFSTI.

Thesis.

Equilibrium data were obtained for the systems MCl_3–HCl H_2O–1M D2EHPA (in Amsco Odorless Mineral Spirits), where M is used to designate the trivalent rare earths, Gd, Dy, Er, and Yb, over the entire concentration range of the rare earth chloride in aqueous solution. For a particular acidity and a given rare earth concentration in the aqueous phase, it was found that extractability increased as the atomic number of the rare earth increased. Equilibrium acid concentration was used as a parameter in determining the equilibrium curves, and the general shape of these curves changed as the aqueous acid concentration increased from 1.4 to 5.0M HCl. At the lower acidities the equilibrium curves increased to a maximum and then decreased slowly as the aqueous rare earth chloride concentration increased to saturation. As the aqueous phase acidity increased, the curve reached a maximum and then leveled off, until at high acidities the organic concentration of the solute rose steadily with increasing concentration of rare earth chloride in the equilibrium aqueous phase. The separation factor of Dy with respect to Gd, $\beta_{Dy,Gd}$, was also obtained in acidic chloride solutions. There apparently were slight effects of total rare earth chloride concentration, total acidity, and the molar ratio of $GdCl_3$ to $DyCl_3$ in the equilibrium aqueous phase on the separation factor, but this separation factor was in the range of 9 to 13 for the conditions studied. The concentration of chloride in the equilibrium organic phase was determined for the systems HCl–H_2O–1M D2EHPA, $LaCl_3$–HCl–H_2O–1M D2EHPA, and $YbCl_3$–HCl–H_2O–1M D2EHPA. Chloride-containing species were extracted from HCl solutions of 6M or greater, and the concentration of chloride in the organic phase increased as the aqueous acidity increased. Chloride was also extracted from aqueous solutions containing varying concentrations of the two rare earth chlorides, $LaCl_3$ and $YbCl_3$, together with approximately 4.8M HCl, and the organic chloride concentration increased as the concentration of rare earth chloride increased. These data indicated that the extraction of rare earths is not entirely by the extraction of the trivalent ion by an ion-exchange reaction, but that rare earth chloride complexes may be extracted, possibly by ion-exchange

reactions, and the neutral species, MCl_3 and HCl, may also be extracted. Yb and Lu were not removed from the organic phase by stripping four times with double volumes of 6M HCl and other methods of back-extracting previously used. A 20% hydrofluoric acid solution completely removed the solute from the organic phase as the insoluble fluoride. (auth)

6368 (IS-T-197) SOLVENT EXTRACTION OF Eu(III) INTO MIXTURES OF THENOYLTRIFLUOROACETONE WITH VARIOUS ALKYLPHOSPHINE OXIDES. Carey, Mark Allen (Ames Lab., Iowa). Nov. 1967. Contract W-7405-eng-82. 138p. Dep. CFSTI.

Thesis.

An extensive review of synergic solvent extraction is given, including a review of the explanations that have been proposed for the phenomenon of synergism. The solvent extraction of tracer europium(III) from chloride medium (μ = 0.1 into mixtures of thenoyltrifluoroacetone (HTTA) with methylenebis(di-n-hexylphosphine oxide), MHDPO; trimethylenebis(di-n-hexylphosphine oxide), PHDPO; tetramethylenebis (di-n-hexylphosphine oxide), BHDPO; or tri-n-octylphosphine oxide, TOPO, in cyclohexane was studied. The dependence of the distribution ratio on pH, on $[HTTA]_0$, and on the concentration of the neutral organophosphorus compound was determined by an application of the law of mass action. The europium-containing species in the organic phase were shown to be $Eu(TTA)_3(TOPO)_2$, $Eu(TTA)_3$(MHDPO), $Eu(TTA)_3$(PHDPO), and $Eu(TTA)_3$(BHDPO). The equilibrium constants for the formation of the complexes were calculated, and it was found that the stabilities of the adducts of $Eu(TTA)_3$ with the diphosphine oxides increase in the order MHDPO < PHDPO < BHDPO. A molar ratio study of the extraction of europium(III) from an acetate buffer with a pH of 5.5 was used to confirm the composition of the complexes listed and to show the formation of $Eu(TTA)_3(TOPO)$ as well. The formation of $Eu(TTA)_3(TOPO)$ was confirmed by a loading capacity study and by a fluorometric molar ratio study. The solvent extraction of tracer europium(III) from perchlorate medium (μ = 0.1) into mixtures of HTTA and TOPO or of HTTA and MHDPO in cyclohexane was studied. The law of mass action was applied to both of these systems. The variables pH, $[HTTA]_0$, $[TTA^-]$, and $[TOPO]_0$ were considered in the first system, and the variables pH, $[HTTA]_0$, $[MHDPO]_0$, and $[ClO_4^-]$ were considered in the second system. The method of continuous variations was applied to the system containing MHDPO. The europium-containing species in the organic phase were shown to be $Eu(TTA)_3(TOPO)_2$ and $Eu(TTA)(MHDPO)_3(ClO_4)_2$. In the latter case the loss of chelation energy due to the replacement of two TTA ligands was compensated by the formation of a more stable complex containing three stable rings with bidentate MHDPO. Equilibrium constants for the formation of the two complexes were calculated. The solvent extraction of tracer europium(III) from perchlorate medium (μ = 0.1) into mixtures of HTTA and MHDPO in 1,2-dichlorobenzene was also studied. Application of the law of mass action and the method of continuous variations indicated that under most conditions more than one complex is extracted and that the composition of the predominant mixed ligand complex is probably dependent on these conditions. All of the bifunctional phosphine oxides are thought to be bidentate in the complexes found here, and europium(III) is apparently octacoordinate in each complex. The analytical usefulness of the fluorescence of mixed ligand complexes of europium with TTA and a neutral organo phosphorus compound is illustrated. (auth)

6369 (RFP-1048) STATIC BED REACTOR FOR STUDIES OF A PLUTONIUM HEXAFLUORIDE VOLATILITY PROCESS. Moseley, Jerry D.; Robinson, Herbert N. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Dec. 5, 1967. Contract AT(29-1)-1106. 19p. Dep. CFSTI.

Studies were begun to find if chemical separation and purification of plutonium from waste material could be achieved with fluoride volatility processes. Equipment designed for the project and the procedures developed for use are described. (auth)

6370 DIBUTYL CARBITOL SOLVENT EXTRACTION OF ^{210}Po FROM NITRIC ACID SOLUTIONS OF IRRADIATED BISMUTH. Schulz, Wallace W.; Richardson, Gerald L. (Battelle Memorial Inst., Richland, Wash.). Ind. Eng. Chem., Process Design Develop., 7: 149-56(Jan. 1968).

A dibutyl carbitol (DBC) solvent extraction process for recovery and purification of ^{210}Po from nitric acid solutions of irradiated bismuth metal was developed. It is suitable as a head-end step in recovery of kilogram quantities of ^{210}Po for subsequent use in isotopic power sources. It involves countercurrent extraction of polonium from an aqueous nitric acid–bismuth nitrate feed solution containing about 4 curies per liter of ^{210}Po into approximately a double-volume portion of DBC. The resulting organic extract is scrubbed with 3M HNO_3 to provide further decontamination from bismuth; polonium is then stripped into a 0.2M HNO_3 solution. In laboratory and pilot plant demonstration tests, over-all ^{210}Po recoveries were 98% or greater while over-all bismuth decontamination factors were typically 1500 or higher. (auth)

6371 THERMITE PROCESS FOR THE FIXATION OF HIGH-LEVEL RADIOACTIVE WASTES. Spector, M. L. (M. W. Kellogg Co., New Market, N. J.); Suriani, Ernesto; Stukenbroeker, G. L. Ind. Eng. Chem., Process Design Develop., 7: 117-22 (Jan. 1968).

In a unique approach to final fixation of radioactive by-products from the fission process, the radioactive liquid wastes were reduced in volume, converted to an oxide or a sulfate mass, and reduced to an insoluble polysilicate by the appropriate thermite reaction. The conceptional designs discussed were not fully converted to practice; however, sufficient laboratory studies were performed to confirm the basic principles presented. (auth)

6372 STUDIES ON THE MIST REMOVAL IN THE EVAPORATION–CONDENSATION OF RADIOACTIVE LIQUID WASTES. Kadoya, Shozo; Muramatsu, Takio (Ebara Mfg. Co., Ltd., Tokyo). Ehara Jiho, 15: No. 60, 25-30(Dec. 1966). (In Japanese).

A packed type evaporation tower was constructed in which a packed column was used as the mist trap, and the condensed water was refluxed from the top. The relationship between the amount of evaporation, the reflux ratio, the number of theoretical stages, and the decontamination factor was studied. Since the prevention of formation the mist in the evaporation is also effective in increasing the decontamination efficiency, a study was made on the efficiency of a rotating-blade tower; in this tower, the liquid to be condensed is allowed to fall on the heated blades for evaporation. Useful data were obtained for the two types of evaporation towers, which may lead to their practical use for radioactive liquid wastes. Their feasibility for use with high-level liquid wastes was also investigated and confirmed. The two types were also found to be suitable for the small-scale operation of treatment of liquid wastes with the ease and reduced cost of operation. (NSA of Japan)

6373 RADIOACTIVE EFFLUENT TREATMENT PLANT. Kadoya, Shozo; Muramatsu, Takio (Ebara Mfg. Co., Ltd., Tokyo). Ehara Jiho, 15: No 59, 24-30(Sept. 1966). (In Japanese).

A description is given of the active effluent treatment plant (AETP) installed at the Tokai atomic power station, including its design and construction and the problems involved. In the design, a study was made as to whether the process would use adsorbent or ion exchangers. Since the cartridge cooling pond is of a high pH solution, CO_2 is used as the coagulant after neutralization. The AETP consists of a cartridge cooling pond treatment system, a miscellaneous active effluents treatment system, and an evaporation treatment system. In the cartridge pool the effluent is decontaminated by neutralization with CO_2, precipitation by coagulation, sand filtration, treatment with Na-type ion exchanger, treatment with H-type ion exchanger, decarboxylation, and treatment with weak basic anion exchanger. For desalination in the miscellaneous treatment system, the radioactive effluents are subjected to a batch-type coagulation precipitation, sand filtration, and treatment with a mixed-bed ion exchanger. In the evaporation treatment system, the effluent is neutralized, evaporated, condensed, and the condensate is stored. (TSS)

6374 STUDIES ON THE TREATMENT OF RADIOACTIVE WASTE WITH ION EXCHANGERS DERIVED FROM SAWDUST. I. PREPARATION OF CATION EXCHANGERS AND REMOVAL OF RADIOACTIVE Sr. Egawa, Hiroaki (Kumamoto Univ., Japan). Kumamoto Daigaku Kogakubu Kenkyu Hokoku, 16: 18-22(Feb. 1967). (In Japanese).

Two types of cation exchanger, Cell-P and Cell-S, were prepared by esterifying sawdust with H_3PO_4 and H_2SO_4, respectively, and their separation abilities were investigated for radioactive ^{85}Sr. The preparation of Cell-P and Cell-S are, respectively, as follows: 1 g of sawdust was soaked in a 5-ml solution of 20 g 85% H_3PO_4, 20 g urea, and 30 g water, and treated at 150 to 160°C for 30 to 40 min; 1 g of sawdust was soaked in a 4- to 5-ml solution of 15 g concentrated H_2SO_4, 20 g urea, and 30 g water, and treated at 160 to 170°C for 30 to 40 min. The pH, salt concentration, and flow rate of a waste water were investigated for the separations. At pH 2 to 4, 99.8 and 99.3% separations were obtained for the H-type and Na-type exchangers, respectively. For the Cell-S-H type exchanger, the separation ability tended to decrease rapidly at salt concentrations higher than 200 mg/l, but for the Cell-S-Na type the efficiency was more than 99.6% at a salt concentration of 1000 mg/l. Other types of exchangers also showed higher than 98% separation at the salt concentration of 1000 mg/l. (NSA of Japan)

6375 CO-PRECIPITATION OF CERTAIN RARE EARTH HYDROXIDES WITH SELENITE IONS. Plotnikov, V. I.; Kochet-

kov, V. L.; Chinaeva, V. P. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 71-6(Mar.-Apr. 1967). (In Russian).

The co-precipitation of selenite ions with La, Pr, Nd, Gu, Tb, Dy, Er, or Yb hydroxide was studied as a function of pH of the solution. It was shown that selenium co-precipitation depends on the ionic radius of the elements. The effects of carbonate ions on selenium sorption were also studied. (R.V.J.)

6376 EXTRACTION OF ACTINIDES BY ALKYL-SUBSTITUTED AMMONIUM SALTS. Mueller, W. (European Transuranium Inst., Karlsruhe, Ger.). Actinides Rev., 1: No. 1, 71-119(Sept. 1967).

Alkyl-substituted ammonium salts, dissolved in organic diluents, are frequently used for the extraction of actinide elements from aqueous phases. The properties of the extractant in organic solution are described with special emphasis on the stability of the ammonium salt in presence of aqueous phases (hydrolysis, extraction of excess acid) and on the part played by ion pairs and their dissociation and association. The extraction of actinides, in particular from nitrate and chloride solutions, is reviewed according to the oxidation numbers of the elements. The discussion is limited to the factors affecting the extraction equilibria, type and concentration of the extractant, nature of the organic diluent, composition of the aqueous phase, and to the composition of the metal complex in the organic phase. Practical applications and technical aspects are not considered. (auth)

6377 CRITICALITY OF HETEROGENEOUS ARRAYS UNDERGOING DISSOLUTION. Richey, C. R. (Battelle Memorial Inst., Richland, Wash.). Nucl. Sci. Eng., 31: 40-8(1968).

Experimental data to establish criticality control specifications for enriched uranium rods undergoing dissolution are extremely limited. A principal difficulty in treating the problem theoretically is that the resonance absorbing ^{238}U is admixed in the aqueous solution in which the rods are immersed. The "narrow resonance" and "infinite mass" approximations are applied; and from this application, expressions are developed for treating resonance capture by an absorbing lump embedded in a moderator admixed with the absorber. The computed change in the critical buckling of a heterogeneous array on replacing the water moderator by a uranyl nitrate solution is in good agreement with experiment. Results from survey calculations for 3 and 5 wt % ^{235}U rods latticed in uranium-water mixtures are given. It was concluded that for enrichments up to 5 wt % ^{235}U, dissolver vessels designed geometrically safe for water-moderated arrays of uranium rods will remain safe during the dissolution process. (auth)

6378 CRITICALITY ANALYSIS FOR ISOLATED UNIT CONTAINING SOLUTIONS OF ^{235}U. Simonetta, R.; Bedini, R. Riv. Ing. Nucl., 5: 1329-40(Mar.-June 1967). (In Italian).

A method for the calculation of K_{eff} of a moderated unit containing highly enriched U was developed based on experimental data from various sources. The method is applied to the study of reprocessing installation. (J.S.R.)

6379 EXTRACTION OF SMALL QUANTITIES OF STRONTIUM AND YTTRIUM BY NAPHTHENIC ACIDS. Efendiev, G. Kh.; Makov, N. N.; Alekperov, R. A. (Inst. of Inorganic and Physical Chemistry, Baku). Azerb. Khim. Zh., No. 2, 93-7(1967). (In Russian).

The conditions for extraction of small quantities of strontium and yttrium from aqueous solutions with naphthenic acids (molecular weight 200) in the presence of different organic solvents were investigated by means of radioisotopes. It was shown that naphthenic acids show a large extraction capacity with respect to Y both from pure water and from highly mineralized water. The extraction of Sr proceeds at very high pH values. In the presence of both Sr and Y in the aqueous solution, extraction proceeds at the same order of magnitude as in separate extractions. In the pH interval from 5 to 6, the maximum in the separation of Sr and Y occurs. (tr-auth)

6380 INFLUENCE OF METAL HYDROXIDE PROPERTIES ON SORPTION OF SELENITE IONS. Plotnikov, V. I.; Kochetkov, V. L. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. Nauk, No. 2, 66-70(Mar.-Apr. 1967). (In Russian).

The co-precipitation of selenite ions with iron, zirconium, yttrium, scandium, thorium, and titanium hydroxides using potassium hydroxide as precipitant was studied as a function of the pH of the solution. The influence of the duration of precipitant association with the solution on co-precipitation was also determined. (R.V.J.)

6381 PROGRESS IN WASTE-DISPOSAL RESEARCH AND DEVELOPMENT. Fineman, Philip. Reactor Fuel-Process. Technol., 10: 253-8(Summer 1967).

Topics covered include: incorporation of intermediate-level-activity wastes in asphalt, conversion of high-level-activity wastes to solids, rising-level pot glass processes, phosphate-glass process, and management of highly radioactive solid wastes from the EBR-II fuel cycle facility. (M.C.G.)

6382 RESEARCH AND DEVELOPMENT ON AQUEOUS PROCESSING. Stevenson, C. E.; Paige, D. M. Reactor Fuel-Process. Technol., 10: 241-52(Summer 1967).

Means of dissolving U–Zr alloys, Zircaloy-clad ZrO_2–UO_2 ceramics, and uranium in graphite-matrix fuels are being studied. The recovery of actinides after nuclear detonations in volcanic formations is reviewed. Neptunium extraction from Purex wastes and ^{231}Pa purification are described. Plant and equipment development is reviewed. (M.C.G.)

6383 COMPACT PYROCHEMICAL PROCESSES. Johnson, T. R. Reactor Fuel-Process. Technol., 10: 226-40(Summer 1967).

Topics covered include: liquid metal–salt extraction processes, electrolytic processes, and zone melting. Most of the developmental work is directed toward the recovery of fast breeder reactor fuels. (M.C.G.)

6384 VOLATILITY PROCESSES. Barghusen, J. J. Reactor Fuel-Process. Technol., 10: 226-33(Summer 1967).

The nitrofluor process, studies on irradiated highly enriched alloy fuels, fluid-bed fluorination of UO_2–PuO_2 fuel with ClF_3, use of BrF_3 in processing of PuO_2–UO_2 fuels, environmental contamination control for volatility processing, corrosion, and reactions of fluorinating agents with water are discussed. (M.C.G.)

6385 SOLVENT EXTRACTION CHEMISTRY. Proceedings of the International Conference held at Goteburg, Sweden, 27 August–1 September 1966. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967. 707p. $32.00. (CONF-660805). DTIE.

Eighty papers are included; separate abstracts were prepared for 33. Five papers were previously abstracted in NSA as 20: 38855, 40876, 43424, and 45800 and 21: 28058. The remaining 42 papers include information on: complexing in aqueous solutions by solvent extraction; chelate extraction and adduct formation; neutral and acid phosphoryl compounds as extractants; alkyl ammonium salts and other ion-pairs as extractants; structural effects and interfacial phenomena; and molten phases, miscellaneous systems, and techniques. The industrial application of solvent extraction is presented in discussion form. (P.C.H.)

For abstracts of individual papers see: 6386–6418.

6386 THE USE OF SOLVENT EXTRACTION OF METAL CHELATES FOR THE INVESTIGATION OF COMPLEXATION IN AQUEOUS SOLUTIONS. Stary, J. (Dept. of Nuclear Chemistry, Prague). pp 1-10 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

A review is presented on the mechanism of complexation in aqueous solutions, which is based on the measurement of the distribution of the metal in the presence and absence of complexing agent. The advantages and disadvantages of the extraction method for the investigation of complexation in aqueous solution are discussed briefly. (P.C.H.)

6387 SOLVENT EXTRACTION OF HYDROXO- AND ACIDO-COMPLEXES IN THE PRESENCE OF A CHELATING AGENT. THE PHOSPHATO- AND THE TRICHLOROACETATO-COMPLEXES OF PENTAVALENT PROTACTINIUM. Guillaumont, R.; Muxart, R.; Bouissieres, G. (Institut de Physique Nucleaire, Arcueil, France). pp 11-17 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

A computation method was developed for the more general case when a third ligand, other than OH^- and the chelating agent, is present in the solvent extraction system and replaces some hydroxyl groups of $M(OH)_n^{(n-e)+}$ where $n > 0$ to take part in the composition of the aqueous soluble complexes and eventually in that of the organic soluble species. The method is applied to the particular case of the phosphato- and trichloroacetato-complexes of quinquevalent protactinium. (P.C.H.)

6388 FURTHER STUDIES ON COMPLEX FORMATION BETWEEN Pa(V) AND ACETYLACETONE. Liljenzin, J. O.; Rydberg, J. (Chalmers Univ. of Tech., Goteborg). pp 18-25 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

Improvements were made in the formation of complexes between protactinium and acetylacetone from solvent extraction experiments. A fairly good estimate of the complex formation and distribution constants were obtained. Difficulties, such as unexpected background extraction of Pa(V) into pure xylene, large scatter in the measurements, and uncertainty about the occurrence of polynuclear complexes are discussed. (P.C.H.)

6389 ON THE STABILITY OF CHELATE-COMPLEXES OF POLONIUM(IV). Koch, H.; Falkenberg, W. D. (Dept. of Applied Radioactivity, Leipzig). pp 26-31 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

The liquid–liquid distribution method was used to measure the stability constants of the TTA, NTA, EDTA, oxalate, tartrate, and citrate complexes of Po(IV) with benzene as the organic solvent. The curves, for all the complexing anions used, had a constant slope of two. The results showed that Po(IV) forms relative stable complexes. It was assumed that the Po-chelates have a ligand number of six. Data on stability constants are tabulated. (P.C.H.)

6390 SOLVENT EXTRACTION STUDY OF THE HYDROLYSIS OF TELLURIUM(IV) AT VERY LOW CONCENTRATION IN ACID PERCHLORATE MEDIA. Sekine, T. (Tokyo Coll. of Science). pp 32-8 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

The mononuclear hydrolysis of Te(IV) was studied by solvent extraction into hexane containing trioctylphosphine oxide (TOPO). The results indicated that only the mononuclear hydrolyzed species, $H_3TeO_3^+$, H_2TeO_3, and $HTeO_3^-$, exist in the aqueous phase in the concentration ranges of H^+ and Te(IV) studied. The neutral species exist only at low relative concentrations in a narrow range of $-\log[H^+]$. The neutral species in the organic phase combines with one molecule of TOPO. In 0.1 M perchlorate media, the hydrolysis occurred in a lower $-\log[H^+]$ range than in 3 M perchlorate media. The partition coefficient, K_D, of the neutral species was larger in 3 M perchlorate media than in 0.1 M perchlorate media. (P.C.H.)

6391 THE FIRST HYDROLYSIS CONSTANT OF THE SCANDIUM(III) ION MEASURED BY A SOLVENT EXTRACTION TECHNIQUE Schweitzer, George K.; Winkley, Donald C. (Univ. of Tennessee, Knoxville). pp 39-45 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

The discovery and use of a chelate solvent extraction system for the determination of the first hydrolysis constant of Sc is described. The resulting value was compared with values obtained by the potentiometric approach. Several different chelating agents were used in a preliminary survey in order to identify an appropriate agent for the final determinations. The value found by solvent extraction was about a factor of 10 larger than that reported from the potentiometric data. (P.C.H.)

6392 THE SEPARATION OF THE RARE EARTHS BY SOLVENT EXTRACTION AND REVERSED-PHASE CHROMATOGRAPHY FROM COMPLEXED AQUEOUS SOLUTIONS. Werner, G. (Karl Marx Univ., Leipzig). pp 54-9 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

The effects of EDTA on the distribution coefficients of La, Ce, Pr, and Nd in TBP–sodium perchlorate and dinonylnaphthalenesulfonic acid (DNS)–hydrochloric acid systems, and the analogy of liquid and resinous cation exchange behavior of alkaline earths and rare earths were studied. The distribution coefficients of alkaline earths and rare earths with DNS confirmed that real liquid cation exchange occurs. The complete separation of the four rare earths was possible. The separation of the La/Ce and Ce/Pr pairs gave rise to no difficulties. For the separation of Pr/Nd very small amounts of the elements must be spotted. (P.C.H.)

6393 SYNERGISM IN THE SOLVENT EXTRACTION OF METAL CHELATES. Irving, H. M. N. H. (Univ. of Leeds, Eng.). pp 91-110 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

A review is presented on synergism during the solvent extraction of metal chelates. Diluent effects are also discussed. A survey of several cases of synergism that have come to light recently are discussed. It was concluded that the phenomenon of synergism, originally believed to be so restricted in its scope, is very widespread indeed and examples of quite novel synergic combinations may still await discovery. (P.C.H.)

6394 SYNERGISM IN THE SOLVENT EXTRACTION OF ALKALI METAL SPECIES. Healy, T. V. (Atomic Energy Research Establishment, Harwell, Eng.). pp 119-27 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

Synergism in the solvent extraction of alkali metals was studied by the two-metal, two-solvent, and two-solvent/two-metal systems. The other metals studied included K, Na, Li, UO_2, Ce, and Ca. The two-solvent systems contain alkali metals and thenoyl trifluoroacetone (TTA) plus neutral donor solvents. The effects of TBP addition to the two-metal systems showed that the two-metal TTA complex is broken down gradually, ending up with the one-metal HTTA/TBP complex. Addition of nitromethane to the two-metal complex did not destroy it, but enhanced the extraction. This enhancement of D_{Cs} by nitromethane in the presence of Na was less than in the presence of lithium but greater than in the presence of K. Enhancement of Cs extraction by addition of Na salt to bis(2-ethylhexyl) phosphate (HDEHP) can be combined with the other enhancement of Cs extraction by addition of certain long chain phenols to HDEHP. This double synergism can lead to an overall increase of D_{Cs} by $>10^5$ giving Cs distribution coefficients of up to 1000 at pH 4 to 7. (P.C.H.)

6395 THE SOLVENT EXTRACTION OF HAFNIUM(IV) AND ZIRCONIUM(IV) BY N-BENZOYL-N-PHENYLHYDROXYLAMINE AND 2-THENOYLTRIFLUOROACETONE FROM STRONGLY ACIDIC SOLUTIONS Hala, J. (Univ., Brno). pp 135-41 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

Studies were made on the mechanism involved in the solvent extraction of Zr and Hf from perchloric and hydrochloric acid using 4,4,4,-trifluoro-1-(2-thienyl)-1,3-butanedione (TTA) and N-phenylbenzohydroxamic acid (HBPHA). It was concluded that the differences in the extraction curves from perchloric and hydrochloric acid solutions can be most likely ascribed to the different activity coefficients of X^- anions in the aqueous phase. (P.C.H.)

6396 EXTRACTION OF METAL CATIONS WITH CHLOROPHOSPHONAZO DAL. Budesinsky, B.; Haas, K. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). pp 173-81 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

The basic photometric properties of chlorophosphonazo DAL (CPA-DAL) for the extraction of metal ions were studied. The formation of metal complexes of CPA-DAL and the conditions of their extraction showed that the CPA-DAL appears as a promising extractive photometric reagent for uranium(VI), with the use of EDTA as masking reagent. It can also be used for quantitative masking of Zr, Hf, Y, and lanthanides. (P.C.H.)

6397 TBP: MEETING-POINT OF SCIENCE AND TECHNOLOGY. McKay, H. A. C. (Atomic Energy Research Establishment, Harwell, Eng.). pp 185-94 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

The properties of TBP that appeal to the solution chemist and the process chemist are discussed. The properties include extracting power, stability, solubility, third phase formation, hydrodynamic behavior, and cost and availability. Some of the complications with TBP are the occurrence of hydrolysis, formation of nitrato anions, and the presence of water. The mechanism of ruthenium reactions with TBP are discussed. (P.C.H.)

6398 PROBLEMS IN THE PHYSICAL CHEMISTRY OF SOLVENT EXTRACTION. Rozen, A. M. (Cybernetics Council, Moscow). pp 195-235 of Solvent Extraction Chemistry.

Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

The problems of extraction equilibria are discussed in terms of equilibrium constant and concentration dependence of the chemical potential in the aqueous and organic phases. The electrolyte–nonelectrolyte is used as an example. It was concluded that satisfactory description and prediction of extraction isotherms in complicated nonideal systems is possible. The present-day level of theoretical knowledge permits interpretation and description of the majority of the observed phenomena to be made. The main task is to increase the predictive ability of the theory. (78 references). (P.C.H.)

6399 EXTRACTION OF URANIUM FROM URANYL SULPHATE AND URANYL CHLORIDE SOLUTIONS WITH TRI- AND DICAPRYLPHOSPHATES. Szabo, E.; Balazs, A.; Bakos, L. (Central Research Inst. for Physics, Budapest). pp 236-42 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

Studies were made on the extraction mechanism of trioctyl phosphate (TOP) for uranium in chloride and sulfate solutions. Distribution isotherms were measured on 0.125, 0.25, 0.5, and 1.0 M TOP solutions in kerosene. In the uranyl sulfate and uranyl chloride–TOP–kerosene systems the uranyl to phosphorus atom ratio of the solvate complex was found to be 1:4. This value did not change when benzene or petroleum ether was used instead of kerosene. On the basis of the results the following chemical reaction is proposed: $UO_2^{2+} + 4R_3PO_4(org.) + 2H_2O \rightarrow UO_2(P_2PO_4)_2 \cdot 2R_3PO_4(org.) + 2ROH(org) + 2H^+$. The same extraction mechanism of cation exchange type can be proposed for using primary 2-ethylhexyl alcohol in the neutral organophosphorus compound instead of capryl alcohol. (P.C.H.)

6400 THE EFFECT OF DILUENT ON THE SOLVENT EXTRACTION OF Tb(III) AND Eu(III) BY DI-n-OCTYL PHOSPHORIC ACID. Kolarik, Zdenek (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Rez). pp 250-5 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

The effects of diluent on the composition of extractable complex and on extraction and separation efficiency were studied. The extraction efficiency of dioctyl phosphate (HDOP) for Tb(III) and Eu(III) for the diluents studied was illustrated by the equilibrium constants of extraction reactions; for methyl isobutyl ketone, this constant is defined as $K_{eq} = D_{Ln}[H^+]^3[HA]^x_{org}$ and for other diluents $K_{eq} = D_{Ln}[H^+]^3[H_2A_2]^{x-}_{org}$, where x = 3 of 2.5. Of the donor-type diluents butyl ether was characterized by the lowest suppressing activity towards the extraction of Tb(III) and Eu(III) by HDOP. It was slightly more suppressed by aromatic hydrocarbons; the value of K_{eq} fell in the order: p-xylene ≃ o-xylene > toluene > chlorobenzene > benzene. The separation efficiency of HDOP in various diluents is expressed by the separation factor for the Tb(III)–Eu(III) pair. In most diluents, the separation efficiency of HDOP was almost the same, with the exception of toluene and xylenes. The separation factor was somewhat lower only in aliphatic hydrocarbons and cyclohexane. It was concluded that the partition coefficient of LnA_3 changes only slightly with atomic number (Z) and its contribution to the separation efficiency of dialkyl phosphates is not of great importance. (P.C.H.)

6401 COMPLEX FORMATION BETWEEN NEUTRAL ORGANOPHOSPHORUS COMPOUNDS AND DI-ALKYLPHOSPHORIC ACIDS AND ITS EFFECT IN METAL EXTRACTION. Liem, Djiet Hay (Royal Inst. of Tech., Stockholm). pp 264-9 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

The various equilibria between dibutyl phosphate (HDBP) and TBP or trioctylphosphine oxide (TOPO) between aqueous 0.10 M H_2SO_4 and hexane or CCl_4 were studied from the distribution of ^{32}P-labeled HDBP. Sets of $(HA)_pB_q$ where HA and B are combined extractants complexes and equilibrium constants were HA and B are combined extractants, which were found to give the lowest value of the error-square sum, U, are tabulated. The addition of H_4A_4 was found to give a better U value than other polymeric HDBP species, like H_3A_3, H_6A_6, or H_8A_8. The fit between experimental data and the curves was quite good. Curves calculated for the extraction of U(VI) into hexane from 0.10 M H_2SO_4 solution for different constant values of the total concentration of HDBP as a function of the total concentration of TBP are illustrated. (P.C.H.)

6402 SOLVENT EXTRACTION PROPERTIES OF METHYLENEBIS(DIALKYLPHOSPHINE OXIDES). O'Laughlin, J. W.; Banks, C. V. (Iowa State Univ., Ames). pp 270-7 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

Studies were made on the extraction of water and mineral acids, and the use of methylenebis[di-n-hexylphosphine oxide], MHDPO, and methylenebis[bis-2-ethylhexylphosphine oxide], MEHDPO, as stationary phases in extraction chromatography. Near infrared and Karl Fischer data for extraction of water by CCl_4 solutions of MHDPO and trioctylphosphine oxide are given. Data for the extraction of nitric and perchloric acids by 0.05 M and 0.10 M solutions of MHDPO in CCl_4 showed that at low acid activities the slope of $\log[H^+]_{(o)}$ against $\log(H^+X^-)$ approaches a value of 1 for nitric acid but was somewhat less than 1 for perchloric acid. Plots of $\log[H^+]$ against $\log[MHDPO]$ were linear with a slope of 1 for 0.1 M and 1 M nitric acid. Although much larger partition coefficients were observed for the extraction of rare earth perchlorates (Tb, Dy, and Ho), the separation factors between adjacent rare earths increased in the order perchlorates ≪ chlorides < nitrates, and in the case of the latter two salts with the hydrochloric or nitric acid concentration in the aqueous phase. (P.C.H.)

6403 SOME NOVEL PHOSPHORYL COMPOUNDS AS EXTRACTANTS FOR ZIRCONIUM, NIOBIUM, AND TANTALUM. Meider-Gorican, H. (Inst. Rudjer Boskovic, Zagreb). pp 278-92 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

The solvent extraction of Zr, Nb, and Ta from chloride, sulfate, and nitrate solutions with bis(dihexylphosphinyl)methane, $(C_6H_{13})_2OPCH_2PO(C_6H_{13})_2$; dioctyl ester of 1-oxo-octanephosphonic acid, $C_7H_{15}COPO(OC_8H_{17})_2$; and the dioctyl ester of 2-oxopropanephosphonic acid $CH_3COCH_2PO(OC_8H_{17})_2$, is described. The studies were made to investigate the influence of the phosphoryl and carbonyl group, as well as the size of the ring upon the extraction of Zr, Nb, and Ta. The results with bis(dihexylphosphinyl)methane showed that the maximum extraction occurs from nitric acid solutions and the extraction increases with increasing acid concentration. On investigating the extraction with the other two compounds, it was found that the maximum extraction occurs at pH 1, with a constant concentration of sulfate and chloride ions. By increasing the concentration of hydrogen ion, the coefficient of the extraction decreased. A decrease of extraction with an increase in the metal concentration was also found. (P.C.H.)

6404 ACTIVITIES OF TRIBUTYL PHOSPHATE IN TRIBUTYL PHOSPHATE–URANYL NITRATE–WATER SOLUTIONS. Davis, W. Jr.; Mrochek, J. (Oak Ridge National Lab., Tenn.). pp 283-95 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

Experimental data are presented on the equilibrium distribution of uranyl nitrate and water between aqueous and TBP phases and of aqueous and organic-phase densities obtained at 25°C. Activities of TBP, calculated by graphical integration of the Gibbs–Duhem relation, are presented for equilibrium aqueous uranyl nitrate concentrations ranging from 0.05 to 2.00. These activities were used to analyze the distribution data in terms of an equilibrium reaction involving formation of the complex $UO_2(NO_3)_2 \cdot 2TBP$. Density and concentration data were used to estimate the partial molar volumes of the several molecular species in the organic phase. (P.C.H.)

6405 GAS CHROMATOGRAPHIC STUDIES IN THE EXTRACTION SYSTEMS: TBP-DILUENT-NITRIC ACID-WATER-NITRATES OF ACTINIDES AND RARE EARTHS. Apelblat, A.; Hornik, A. (Israel Atomic Energy Commission, Negev). pp 296-304 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

Gas chromatographic studies were made on the effects of diluents on the solvent extraction of Th, Zr, Ce, La, and Y using TBP–diluent–HNO_3–H_2O system. The effects of nitric acid on the activity coefficients of diluents in the uranyl nitrate–HNO_3–TBP–H_2O and TBP–HNO_3–H_2O systems were also studied. The

results showed that the distribution coefficients were higher when TBP was diluted by aromatic hydrocarbons than when diluted by halogen-substituted hydrocarbons. In aromatic hydrocarbons, the number of methyl groups affected the distribution coefficients. An extremely negative deviation in the TBP–$CHCl_3$ system is explained by the existence of a hydrogen bond. Cyclohexane produced nearly ideal solutions with solvates and moderate positive deviations with HNO_3. The behavior of acetone, dioxane, and carbon disulfide was similar: they produced negative deviations with solvates and their activity coefficients decreased with increasing temperature. Calculation of the excess free energy of mixing of H_2O in the TBP + HNO_3 + H_2O system is discussed. (P.C.H.)

6406 SPECTROSCOPIC INVESTIGATION OF U(IV) AND U(VI) EXTRACTION FROM HYDROCHLORIC ACID SOLUTIONS BY NEUTRAL PHOSPHORORGANIC COMPOUNDS. Vdovenko, V. M.; Lipovskii, A. A. (Radium Inst., Leningrad). pp 309-12 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

Spectroscopic studies showed that U(IV) and U(VI) chlorides can form compounds with TBP containing two or three molecules of TBP. On the basis of the changes that occur in visible spectra upon the formation of compounds containing three S-molecules, the formation constants of these compounds in CCl_4-solutions were determined. The results showed that both in the case of U(VI) and U(IV), the type of reactions depends on the relative concentrations of U, HCl, and TBP, i.e., it is determined by the extraction conditions. (P.C.H.)

6407 PHASE EQUILIBRIA IN BINARY AND TERNARY SYSTEMS. Nikolaev, A. V.; Yakovlev, I. I.; Dyadin, Yu. A. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). pp 313-21 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

Studies were made on phase equilibria in binary and ternary systems due to the polar group P → O. Mutual solubility changes in the TBP–tributylphosphine oxide (TBPO) system and systems of water with di-n-butyl phosphonic acid ester derivatives, where the ester radical is changed from CH_3 to C_4H_9. The formation of compounds when the lower critical temperature of solution is realized is discussed. This is illustrated in the melting diagram for TBPO in the presence of light and heavy water. Solubility isotherms are given for the systems: $UO_2(NO_3)_2$–H_2O–butyl dibutylphosphinate; H_2SO_4–H_2O–butyl dibutylphosphinate; and HNO_3–H_2O–butyl dibutylphosphinate. (P.C.H.)

6408 THIRD PHASE FORMATION BETWEEN SOME ACTINIDE NITRATES AND 20 PERCENT TRI-n-BUTYL PHOSPHATE/ODOURLESS KEROSENE. Mills, A. L. (United Kingdom Atomic Energy Authority, Dounreay, Scotland); Logan, W. R. pp 322-6 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

The points of third phase formation were determined for thorium, uranyl, plutonium, and plutonyl nitrates in HNO_3–20 vol % TBP/odorless kerosene (OK) systems by means of distribution coefficient measurements where the metal nitrate concentration was increased from about 10 mg/ml to such a value that third phase formation occurs. The results showed that the limiting solubility of thorium nitrate and plutonyl nitrate in TBP/OK decreased as the acidity of the aqueous phase increased due to the salting out effect of the nitric acid. The limiting solubility of plutonium tetranitrate in TBP/OK increased with increasing aqueous phase acid, reaching a maximum at about 7 M nitric acid, thereafter increase in acidity caused the limiting solubility to decrease. It is postulated that the formation of $H_2Pu(NO_3)_6$ is responsible for the increase in solubility up to 7 M nitric acid and then this complex is salted out from the solvent phase by further increase in aqueous acidity. (P.C.H.)

6409 THE USE OF TARTRATES FOR THE SEPARATION OF URANIUM(VI) AND PLUTONIUM(IV) BY EXTRACTION WITH TBP. Ortega, J.; Ramos Salvador, L.; Lopez Perez, B. (Junta de Energia Nuclear, Madrid). pp 335-42 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

Studies were made on the distribution coefficients of U, Pu, and Zr as a function of sodium tartrate (Na_2T), aluminum nitrate, and nitric acid concentrations. From the quantitative data collected, conditions were chosen to obtain a gradation in the distribution ratios of U, Pu, and Zr ($K_{DU} > 1 > K_{DPu} \gg K_{DZr}$). These conditions were used to run a countercurrent partition system. (P.C.H.)

6410 QUATERNARY AMMONIUM NITRATES AS EXTRACTANTS FOR TRIVALENT ACTINIDES. Van Ooyen, J. (Reactor Centrum Nederland, Petten, Netherlands). pp 485-92 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

The extraction properties of trialkylmethylammonium nitrate for trivalent actinides were studied along with the degree of association of water or inorganic acid if present in the organic solutions. The investigation of the extraction behavior of nitric acid included in particular, the region of very low acidity and high lithium nitrate concentrations, where the extraction of Am had been investigated. The extraction of Am was found to take place in competition with the formation of the trilaurylmethylammonium nitrate ($TLMANO_3$)–nitric acid complex. The extraction of 0.1 M $TLMANO_3$ and 5 M $LiNO_3$ adjusted to pH 2 was found to be very suitable for separation of Am and Cm. (P.C.H.)

6411 RELATIONS BETWEEN DISTRIBUTION RATIOS AND MOLECULAR STRUCTURE OF NIOBIUM AND TANTALUM EXTRACTING SPECIES WITH SOME NOVEL EXTRACTANTS. Djordjevic, C. (Univ. of Zagreb. Inst. Rudjer Boskovic, Zagreb). pp 493-8 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

Comparisons were made of experimental evidence for D relations and the molecular structure of the Nb and Ta extracting species in the organic phase, separated from the organic solvent. Extractants used in the investigations belong to two different classes: chelate phosphoryl and long-chain amine-type reagents. Various systems were studied, and the hydrofluoric and oxalic acid solutions are described. The metal/reagent ratio in the organic phase over different ranges of concentration was examined and the extracting species were separated from the organic phase, obtained under the identical conditions. They were characterized by analysis and some physical measurements. It was found that a direct correlation exists between the molecular structure of these species and the metal/reagent ratio found in the organic phase. However, for systems of a low extraction efficiency, a definite, reproducible logarithmic dependence was found in the organic phase, but it was not possible to isolate the corresponding pure extracting species. (P.C.H.)

6412 SOME EFFECTS OF STRUCTURE IN EXTRACTANT MOLECULES. Siddall III, T. H. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. pp 501-8 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O ; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

It is shown how modern spectroscopic techniques, particularly proton magnetic resonance (PMR), can reveal detailed structural information when applied to solvent extraction problems, and how to relate this information to extractant strength. The more difficult problem of applying such basic information to solvent selectivity is outlined, and the separation of lanthanides and actinides(III), both as groups and also as individual elements, one from the other, within these groups is discussed. (P.C.H.)

6413 ORGANIC OXIDES AS EXTRACTANTS FOR METAL ANIONS. Krasovec, F.; Klofutar, C. (Inst. Jozef Stefan, Ljubljana, Yugoslavia). pp 509-16 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

The basicity (or a property that is affected by the basicity) of organic oxides, which can be represented by the general formula R_nXO; was determined, and the extraction of pertechnetic and perrhenic ions with these reagents was studied. Two types of organic oxide were investigated, namely, those in which R was constant but X was varied and secondly those having different substituents but the same X. In the first type oxide, triphenyl phosphine- and arsineoxide as well as diphenyl selen- and sulfoxide were used. The second type compound consisted of those

containing the phosphoryl group. The results indicated that the extractive power of the organic oxides strongly depends on their basicity. As far as X is concerned, it was found that phosphine- and sulfoxides are relatively weak bases and consequently they exhibit only low extraction efficiency. Corresponding As, Se, and especially Sb and Te compounds are much stronger bases and therefore their extractive power is much higher. The influence of the substituents is determined by their characteristic constant which represents a quantitative measure of their inductive effect. (P.C.H.)

6414 SOLVENT EXTRACTION FROM MOLTEN SALTS. Marcus, Y. (Hebrew Univ., Jerusalem). pp 555-80 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

A review is presented on solvent extraction from molten salts, including mechanisms involved and thermodynamics. Information obtainable from distribution studies is also studied. Data are tabulated with references included. (68 references). (P.C.H.)

6415 THE STUDY OF THE EXTRACTION EXCHANGE REACTION $Cs^+(aq) + H^+(org) \rightleftharpoons Cs^+(org) + H^+(aq)$ BETWEEN AN AQUEOUS PHASE AND NITROBENZENE. Rais, J.; Kyrs, M. (Inst. of Nuclear Research, Czechoslovakia Academy of Sciences, Rez). pp 595-9 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27-Sept. 1, 1966. See CONF-660805.

Studies were made on the exchange reaction of the cation of Cs and the H cation between aqueous and nitrobenzene phases. The equilibrium constant K_{Cs-H} was determined using the system: H_2O–mineral acid–phosphomolybdic acid–tracer amounts of Cs–nitrobenzene. With HCl and HNO_3 media no systematic change of the K′-values with the aqueous acidity was observed. With perchloric acid such a trend appeared. By extrapolating graphically the log K′ values found to zero ionic strength in the aqueous phase the following values of log K′ were obtained: HCl-log K′ = 3.05 ± 0.03; HNO_3-3.00 ± 0.03; $HClO_4$-2.95 ± 0.03. The average value log K′ = 3.00 resulted. It was concluded that nitrobenzene makes a superior extractant for Cs as compared to nitromethane because higher separation coefficients from the alkali metal cations can be obtained. (P.C.H.)

6416 SYSTEMATIC ANALYSIS BY SOLVENT EXTRACTION. PART III. Chalmers, R. A.; Svehla, G. (Univ. of Aberdeen, Scotland). pp 600-4 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

A systematic procedure is described for the separation and determination of solutions that may contain any or all of 27 elements. These elements are: Al, Sb, As, Ba, Be, Bi, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Mo, Ni, Ag, Sr, Th, Sn, Ti, W, V, Zn, and Zr. Cupferron was used as the complexing agent since it formed extractable complexes with most of the metals. The main disadvantage of the modified scheme was that no simple and reliable back-extraction procedure could be found for the cupferronates, and it was necessary to mineralize the cupferron complexes by treatment with H_2SO_4 and HNO_3. On the other hand, the mineralization could be left going on overnight in a fumecupboard, and little working time was lost. Typical ranges of recovery of metals from mixtures are tabulated. (P.C.H.)

6417 EXTRACTIVE PURIFICATION OF MOLYBDENUM-(VI) IN HYDROCHLORIC ACID SOLUTION. II. REMOVAL OF IRON(III). Muehl, P.; Fischer, C.; Guenzler, G. (German Academy of Sciences, Berlin. Inst. of Metal Physics and High-Purity Metals, Dresden). pp 625-9 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

Studies were made on the separation of iron from molybdenum in hydrochloric acid solution by solvent extraction using 3-methyl-1-butanol. It was found that separation can be made at acid concentrations lower than 5.4 M. Only solutions with more than 20% 3-methyl-1-butanol in benzene permitted effective separations. With increasing alcohol concentration the separation factor, ν_i increased, but the yield of molybdenum decreased as the result of higher extractability. Results were similar if kogasine instead of benzene was used as diluent. Tungsten can also be separated from molybdenum by dilution of the aqueous phase to a hydrochloric acid concentration of 6 M and extraction with 3-methyl-1-butanol without diluent. (P.C.H.)

6418 USE OF SOLVENT EXTRACTION FOR SUBSTOICHIOMETRIC DETERMINATIONS OF TRACES OF METALS. Ruzicka, J.; Stary, J.; Zeman, A. (Faculty of Technical and Nuclear Physics, Prague). pp 630-1 of Solvent Extraction Chemistry. Dyrssen, D.; Liljenzin, J.-O.; Rydberg, J. (eds.). New York, John Wiley and Sons, Inc., 1967.

From International Conference on Solvent Extraction Chemistry, Goteborg, Aug. 27–Sept. 1, 1966. See CONF-660805.

Solvent extraction of metal chelates for a substoichiometric separation of traces of metals in connection with activation analysis and isotope dilution is discussed. The factors by which the sensitivity of substoichiometric determination by isotope dilution is limited are listed. (P.C.H.)

6419 PROBLEMI CONNESSI CON LA PROGETTAZIONE E LA COSTRUZIONE DI IMPIANTI PILOTA DI RITRATTAMENTO DI COMBUSTIBILI NUCLEARI. Atti del Simposio Nucleare Internazionale di Torino, 23–24 Settembre 1965. (Problems Encountered in Design and Construction of a Pilot Plant for Reprocessing of Nuclear Fuel. Reports of International Nuclear Symposium, Turin, September 23–24, 1965). Rome, Comitato Nazionale Energia Nucleare, 1967. 239p. (CONF-650964). DTIE.

Eleven papers presented at the conference are included and a separate abstract was prepared for each. (M.C.G.)

For abstracts of individual papers see: 6420–6430.

6420 PILOT PLANT FOR REPROCESSING IRRADIATED FUELS FROM MARCOULE. Faugeras, P.; Couture, J.; Niezborala, F. (CEA, Paris). pp 21-63 of Problemi Connessi con la Progettazione e la Costruzione di Impianti Pilota di Ritrattamento di Combustibili Nucleari. Rome, Comitato Nazionale Energia Nucleare, 1967. (In French).

From Symposium on Design and Construction Problems of Pilot Plants for Recycling Irradiated Fuels, Turin, Sept. 23–24, 1965. See CONF-650964.

In the design of a pilot plant for reprocessing irradiated fuels from Marcoule, the primary considerations were maximum flexibility and remote-control dismantling of the apparatus. The pilot plant is described in detail, with discussion of the building, the hot cells, remote-control apparatus, and analytical control. The operational results with respect to remote control sampling and solution-transfer devices are discussed. The program for future equipment is briefly outlined. (J.S.R.)

6421 DESIGN AND CONSTRUCTION OF THE WINDSCALE PILOT PLANT FOR REPROCESSING NUCLEAR FUEL. Naylor, A.; Baxter, W.; Duncan, A. (United Kingdom Atomic Energy Authority, London). pp 65-88 of Problemi Connessi con la Progettazione e la Costruzione di Impianti Pilota di Ritrattamento di Combustibili Nucleari. Rome, Comitato Nazionale Energia Nucleare, 1967.

From Symposium on Design and Construction Problems of Pilot Plants for Recycling Irradiated Fuels, Turin, Sept. 23–24, 1965. See CONF-650964.

Details are given of the design and construction of a small-scale pilot plant and ancillary equipment used to obtain information on reprocessing of nuclear fuels by dissolution and solvent extraction. Operation and control of the plant under highly radioactive conditions are described. Effluent disposal, small-scale countercurrent contactors, the feed metering system, sampling, operational control, and maintenance are described. (M.C.G.)

6422 EXPERIMENTS PERFORMED WITH THE EUROCHEMIC EXTRACTION–EVAPORATION PILOT PLANT. De Witte, R. (Eurochemic, Mol, Belg.). pp 89-114 of Problemi Connessi con la Progettazione e la Costruzione di Impianti Pilota di Ritrattamento di Combustibili Nucleari. Rome, Comitato Nazionale Energia Nucleare, 1967.

From Symposium on Design and Construction Problems of Pilot Plants for Recycling Irradiated Fuels, Turin, Sept. 23–24, 1965. See CONF-650964.

Work performed with an extraction–evaporation pilot plant operated since August 1960 is described. The pulse columns, metering pumps, mixer-settlers, and chemical flowsheets are described. Research is reported on: column interface control and aqueous phase discharge, air pulsation, determination of dispersed phase holdup in the columns, evaporator control, air lift pumps, steam jets, the L.E.U. cycle, and the H.E.U. cycle. (M.C.G.)

6423 PROBLEMS RELATED TO THE DESIGN OF PILOT PLANTS FOR REPROCESSING BY VOLATILIZATION. Schmets, J.; Heremans, R.; Pierini, G. (CEEN-CEN, Brussels). pp 117-38 of Problemi Connessi con la Progettazione e la Costruzione di Impianti Pilota di Ritrattamento di Combustibili Nucleari. Rome, Comitato Nazionale Energia Nucleare, 1967. (In French).

From Symposium on Design and Construction Problems of Pilot Plants for Recycling Irradiated Fuels, Turin, Sept. 23–24, 1965. See CONF-650964.

Design problems constituting a common denominator in the flowsheets of various pilot plants under construction or at the beginning of their operation using a volatilization process are analyzed. These problems relate to regeneration processes, criticality, control of the material in the installations, capacity of the installations, apparatus, residues, remote-control manipulation and shielding, and safety. (J.S.R.)

6424 THE EUROCHEMIC PLANT AT MOL. BASIC CRITERIA USED IN ITS CONSTRUCTION. Viennot, J.; Lung, M.; Oger, C. (Saint-Gobain Techniques Nouvelles, Courbevoie, France). pp 139-52 of Problemi Connessi con la Progettazione e la Costruzione di Impianti Pilota di Ritrattamento di Combustibili Nucleari. Rome, Comitato Nazionale Energia Nucleare, 1967. (In French).

From Symposium on Design and Construction Problems of Pilot Plants for Recycling Irradiated Fuels, Turin, Sept. 23–24, 1965. See CONF-650964.

In the design of the Eurochemic plant at Mol there were four basic design criteria: response to the reprocessing demands of the fuels from European reactors, reprocessing of varied fuels, maximum flexibility, and minimum cost while assuring the personnel safety. These principles are discussed. The problems caused by the adoption of these principles are indicated and the solutions adopted are described. (J.S.R.)

6425 FLEXIBILITY AND MULTIPURPOSE: TWO ESSENTIAL CHARACTERISTICS OF THE UNITS FOR DISSOLUTIONS AND CONCENTRATION OF FISSION PRODUCTS IN THE EUROCHEMIC PLANT. Schiavello, C.; Lung, M. (Saint-Gobain Techniques Nouvelles, Courbevoie, France). pp 153-71 of Problemi Connessi con la Progettazione e la Costruzione di Impianti Pilota di Ritrattamento di Combustibili Nucleari. Rome, Comitato Nazionale Energia Nucleare, 1967. (In French).

From Symposium on Design and Construction Problems of Pilot Plants for Recycling Irradiated Fuels, Turin, Sept. 23–24, 1965. See CONF-650964.

The principles of flexibility and multipurpose in the design of the Eurochemic plant are illustrated, using as examples the dissolution unit and the unit for the concentration of fission products and recovery of nitric acid. The base data used for the design of the two units are outlined, and a detailed study of the design is given. The dissolver, centrifuge, fission-products evaporator, and the liquid transport system are described. Construction of the two units is discussed. The operational tests made to date are described. (J.S.R.)

6426 THE EUROCHEMIC NUCLEAR CHEMISTRY INDUSTRY AT MOL, FOR THE TREATMENT OF IRRADIATED FUELS. EQUIPMENT OF SPECIAL CONSTRUCTION ALLOYS AT SIAI LERICI, CORMONO (MILAN). Sostero, O.; Narduzzi, F. (Siai Lerici, Milan). pp 173-84 of Problemi Connessi con la Progettazione e la Costruzione di Impianti Pilota di Ritrattamento di Combustibili Nucleari. Rome, Comitato Nazionale Energia Nucleare, 1967. (In Italian).

From Symposium on Design and Construction Problems of Pilot Plants for Recycling Irradiated Fuels, Turin, Sept. 23–24, 1965. See CONF-650964.

The equipment at the Mol Eurochemic plant presented special problems to the contractor and manufacturer of the equipment. The equipment was made of stainless steel or special alloys. The problems in the shaping and construction of this special equipment are outlined. These included purity control of the material, design problems, and control of the intermediate and final products. (J.S.R.)

6427 A REPROCESSING PILOT PLANT AT THE JUNTA DE ENERGIA NUCLEAR OF SPAIN. Lopez Perez, B. (Junta de Energia Nuclear, Madrid). pp 187-98 of Problemi Connessi con la Progettazione e la Costruzione di Impianti Pilota di Ritrattamento di Combustibili Nucleari. Rome, Comitato Nazionale Energia Nucleare, 1967.

From Symposium on Design and Construction Problems of Pilot Plants for Recycling Irradiated Fuels, Turin, Sept. 23–24, 1965. See CONF 650964.

The ventilation, active cells, laboratories, and process equipment are described. Operation and control, waste management, and waste treatment and disposal are discussed. (M.C.G.)

6428 PLANT AT ROTONDELLA FOR THE RECYCLING OF FUELS. Orsenigo, G.; Cambi, S. (Comitato Nazionale Energia Nucleare, Rome). pp 199-207 of Problemi Connessi con la Progettazione e la Costruzione di Impianti Pilota di Ritrattamento di Combustibili Nucleari. Rome, Comitato Nazionale Energia Nucleare, 1967. (In Italian).

From Symposium on Design and Construction Problems of Pilot Plants for Recycling Irradiated Fuels, Turin, Sept. 23–24, 1965. See CONF-650964.

The plant under construction at Rotondella for reprocessing fuels from a uranium–thorium cycle is described. The design criteria are outlined, and the present state of construction is given. The flexibility of the installation is emphasized. (J.S.R.)

6429 CHARACTERISTIC ASPECTS IN THE PLANNING AND CONSTRUCTION OF A PILOT PLANT FOR REPROCESSING, WITH PARTICULAR REFERENCE TO THE SOLVENT-EXTRACTION USING MIXERS-SETTLERS. Dello Siesto, E. (Bombrini Parodi-Delfini, Rome). pp 209-19 of Problemi Connessi con la Progettazione e la Costruzione di Impianti Pilota di Ritrattamento di Combustibili Nucleari. Rome, Comitato Nazionale Energia Nucleare, 1967. (In Italian).

From Symposium on Design and Construction Problems of Pilot Plants for Recycling Irradiated Fuels, Turin, Sept. 23–24, 1965. See CONF-650964.

The experience gained in the construction of the fuel reprocessing pilot plant at Trisaia is analyzed to illustrate some characteristics of design and construction common to all reprocessing plants. The Trisaia installation is described on the basis of a 1:5 scale model. Emphasis in the analysis is on the mixer-settler units of the solvent extraction process. (J.S.R.)

6430 EUREX PLANT. Calleri, G.; Fiorelli, M.; Rolandi, G. (Comitato Nazionale Energia Nucleare, Rome). pp 221-34 of Problemi Connessi con la Progettazione e la Costruzione di Impianti Pilota di Ritrattamento di Combustibili Nucleari. Rome, Comitato Nazionale Energia Nucleare, 1967. (In Italian).

From Symposium on Design and Construction Problems of Pilot Plants for Recycling Irradiated Fuels, Turin, Sept. 23–24, 1965. See CONF-650964.

The Eurex plant is a pilot plant for the reprocessing of irradiated fuels, designed for the processing of fuels of highly enriched uranium of the MTR type. It is also designed for research on a pilot-plant scale of the reprocessing of fuel elements of natural or 5%-enriched U, with cladding of Al, Zr, or stainless steel. The general design of the plant is given, and the design and construction criteria are outlined. The research program planned for the plant is described. (J.S.R.)

6431 FRACTIONATION SEPARATION FOR IRRADIATED URANIUM BY A MULTI-STEP, GRADIENT CONCENTRATION TECHNIQUE. Ishimori, Tomitaro (to Japan Atomic Energy Research Inst.). Japanese Patent 1967-640. Jan. 16, 1967. Filed Apr. 2, 1962.

A method is proposed for the fractionation separation of U; the extraction and the back extraction can be done simultaneously in the same facility, thereby giving FP, Pu, and U separately in its aqueous solution. It can be achieved by the use of a noncontinuous, countercurrent separator such as the settler–mixer. Other advantages obtained are the repeated use of the organic solution, simple operation, and the possibility of its remote operation. Using a noncontinuous, countercurrent separator, the acid, aqueous solutions of gradient concentration are contacted step-wise to the organic solutions containing an extractant, for the aimed purpose. (NSA of Japan)

6432 METHOD FOR RECOVERING URANIUM AND PLUTONIUM VALUES FROM MOLTEN METAL FLUORIDE SALT MIXTURES. (to U. S. Atomic Energy Commission). British Patent 1,093,227. Nov. 29, 1967. Priority date Aug. 14, 1964, United States.

A volatility process is described for the recovery of U and Pu values from molten fluoride salt mixtures containing the two. The metal fluoride salt mixture is heated to the molten state, and the molten fluorides are dispersed into salt droplets that are then contacted with gaseous F_2 to convert the U and Pu values to the hexafluorides, which are also volatile and can then be recovered. (B.L.M.)

6433 METHOD FOR SEPARATING Pu FROM MBP–Pu IN THE TBP SOLVENT EXTRACTION. Takigishi, Masao (to Japan Atomic Fuel Corp.). Japanese Patent 1967-759. Jan. 17, 1967. Filed Nov. 9, 1962.

A method is proposed for separating Pu from MBP–Pu in the TBP solvent phase, which has undergone 1 to 5N HNO_3 stripping after being irradiated in the initial U–Pu extraction process. The solvent phase is scrubbed, with or without addition of fresh solvent, with a HNO_3 solution of such concentration as to maximize the Pu distribution factor for the TBP solvent. (NSA of Japan)

6434 METHOD FOR PURIFYING AND RECOVERING THE USED FUEL-REPROCESSING SOLVENT. Yamamoto, Kan (to Japan Atomic Energy Research Inst.). Japanese Patent 1967-760. Jan. 17, 1967. Filed May 22, 1963.

A method is described for purifying TBP plus its diluent after it has been used in solvent extraction for irradiated nuclear fuels by contacting the solvent mixture with a highly basic OH-type ion-exchange resin to absorb and remove the impurities due to radiation and chemical damages. (NSA of Japan)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 6268, 6487, 6488, 6541, 6572, 6573, 6639, 6666–6668, and 6670.

6435 (MIT–1381-15) VARIATIONS IN ISOTOPIC ABUNDANCES OF STRONTIUM, CALCIUM, AND ARGON AND RELATED TOPICS. (Massachusetts Inst. of Tech., Cambridge. Dept. of Geology and Geophysics). Dec. 1, 1967. Contract AT(30-1)-1381. 165p. Dep. CFSTI.

Results of age estimations and analysis of isotopic abundances in metamorphic rocks in Ghana, Liberia, Sierra Leone, and Uganda in Africa, Brazil, Venezuela, and the Guianas in South America are given. The continental drift of South America from Africa was studied in reference to radiometric ages. Age estimates based on the Sr-86/-87 and Rb/Sr ratios were made for Canadian Shield sediments and anorthosites of the Adirondack syenite. The Rb/Sr ratio was used in the orogenesis of mineral deposits in gold ores. The Sr-86/-87 ratio was used to study the chemical composition of continental crust using graywackes from Wyoming. The age of Maine igneous rock was estimated using the Rb/Sr ratio. The mineral and chemical composition of Greenland ice cap dust was studied. Abstracts are included for papers from the 1966 Geological Society of America's meeting in San Francisco. (F.S.)

6436 (ORNL–4168, pp 1-60) RADIOACTIVE WASTE DISPOSAL. Parker, F. L. (Oak Ridge National Lab., Tenn.).

Research is reported on the following topics: fate of radionuclides in terrestrial environment; disposal by hydraulic fracturing; disposal in natural salt formations; application of mineral exchange to reactor technology; engineering, economic, and safety evaluations; earthquakes and reactor designs; dose-estimation studies related to proposed construction of an Atlantic-Pacific interoceanic canal with nuclear explosives; and related cooperative projects. (M.C.G.)

6437 (STI/PUB–133) SOIL-MOISTURE AND IRRIGATION STUDIES. Panel Proceedings Series. Proceedings of a Panel held in Vienna, 14–18 March 1966. (International Atomic Energy Agency, Vienna (Austria)). Feb. 1967. 120p. (CONF-660338). IAEA: $2.50; S 65,–; 17/8 stg; F Fr 12,30; DM 10,–.

Ten papers were presented at the panel meeting. Separate abstracts were prepared for eight. Two papers on the need of arid and semi-arid regions for water-use efficiency studies and interrelationships between soil moisture, irrigation, drainage, and water-use efficiency were omitted from NSA. (R.C.K.)

For abstracts of individual papers see: 6448–6450 and 6666–6670.

6438 STUDIES OF RADON LEAKAGE IN MINERALS BY ALPHA SPECTROSCOPY. Venkatasubramanian, V. S.; Gopalan, K. (Indian Inst. of Science, Bangalore). pp 206-18 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

Radon leakage in radioactive minerals was measured by alpha spectrometry. The laboratory procedure is described. The effect of temperatures from 200 to 1100°C was determined. The results are discussed in terms of the two mechanisms which account for radon loss from radioactive minerals, i.e., diffusion and recoil mechanisms. (L.C.L.)

6439 AGES OF URANIUM MINERALS BY THE DISEQUILIBRIUM METHOD. Gopalan, K.; Venkatasubramanian, V. S. (Indian Inst. of Science, Bangalore). pp 219-25 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

Methods based on radioactive disequilibrium for dating uranium deposits are discussed. The disequilibrium studies require quantitative estimates of the concentrations of the parent and daughter nuclides. A gridded ionization chamber is being used in these determinations. A method is outlined for estimating the ages of deposition from the peak areas of the alpha spectra. (M.C.G.)

6440 RADIOACTIVITY MEASUREMENTS IN ENVIRONMENTAL SAMPLES IN MONAZITE AREAS. Pillai, T. N. V.; Kamath, P. R. (Atomic Energy Establishment, Trombay, India). pp 274-86 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

Radioactivity measurements were made in environmental samples, such as water, soils, and vegetation, in the monazite areas on the west coast of southern India. Sampling and measurement methods are described. The radioisotopes of interest were thorium-232, radium-224, radium-228, radium-226, and uranium. The results showed that the range of activity due to radium varies from 10^{-5} to 10^{-7} μCi/gm for soils, 10^{-9} to 10^{-10} μCi/gm for vegetables, and 10^{-10} to 10^{-11} μCi/gm for water, and that radium-228 is the limiting isotope from uptake considerations. The radioactivity that finds its way into humans from vegetables from this area is below the MPC level. (L.C.L.)

6441 EVALUATION OF IN-PLACE DENSITY AND MOISTURE CONTENT OF SUBSOIL BY RADIATION LOGGING. Bahadur, Jagdish (CW and PRS, Poona). pp 423-32 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

The equipment and procedure used in evaluation of in-place density and moisture content of the subsoil by radiation logging are described. Reliable results are obtained by this method but a laboratory calibration curve is required. (W.H.K.)

6442 RADIOMETRIC SURVEY AT THE SOUTHERN PART OF MIYAZAKI PREFECTURE. Kiyoshima, Nobuyuki (Geological Survey of Japan). Chishitsu Chosasho Geppo, 17: 509-16 (Aug. 1966). (In Japanese).

Radiometric survey was carried out on the phosphorous nodule in the Tertiary sediments of the Miyazaki formation around Miyazaki city. No radiometric anomaly was found in this area. (NSA of Japan)

6443 RADIOMETRIC SURVEY AT THE SHIKOKU DISTRICT IN 1959. Kiyoshima, Nobuyuki (Geological Survey of Japan). Chishitsu Chosasho Geppo, 17: 502-8(Aug. 1966). (In Japanese).

Radiometric surveys carried out on the beach iron-sand ore deposits in the Setouchi area and the antimony ore deposits in the Shikoku district of Japan in 1959 are described. The radioactive anomaly was not detected in this area except the very slight anomaly on the slug at the Muki mine, Tokushima prefecture. (NSA of Japan)

6444 A SUGGESTED CLASSIFICATION SCHEME OF γ-METHODS IN NUCLEAR GEOPHYSICS. Ochkrug, A. P.; Komisarzhevskaya, G. F.; Pshenichniyi, G. A. At. Energ. (USSR), 23: 246-9(1967). (In Russian).

A classification scheme is proposed to facilitate the evaluation of the various methods based on the interaction of γ radiation with matter, applied to geophysical problems. The physical process involved and the geometry of measurements were used as criteria. The methods were divided in two main groups: those based on the interaction of γ radiation with electrons and atoms, and methods involving the interaction of γ radiation with the nuclei of the elements of interest. The special nomenclature suggested indicates the basic process involved, e.g., Compton scattering, and the geometric conditions involved. Similar methods, such as those used for the determination of the effect of the atomic number, (γ absorption and selective γ-γ logging) are classed together under the heading of "γ-γ photoelectric absorption." The other pertinent methods were similarly analyzed and classified. (TTT)

6445 DOSIMETRY OF ENVIRONMENTAL GAMMA-RADIATION IN POLAND BY MEANS OF GAMMA-RAY SPECTRA IN THE FIELD. Pensko, Jerzy (Central Lab. for Radiological Protection, Warsaw). Nukleonika, 12: 965-75(1967).

Improvements in the spectrometric methods made possible the direct evaluation of exposure rates for the principal gamma emitters of background radiation are described. The results of environmental exposure rate measurements for various places in Poland are presented and discussed. (auth)

6446 DATING BY FISSION FRAGMENT TRACKS. Hasegawa, Shunichi; Sakimura, Masahiko. (Waseda Univ., Japan). Waseda Daigaku Rikogaku Kenkyusho Hokoku, No. 36, 97-103 (Sept. 1966). (In Japanese).

The method of determining the ages of natural minerals by spontaneous fission fragment tracks of ^{238}U has been tested on natural muscovite mica. The development of the method as a tool for exploring the early history of the planetary system is described. Various alternative experimental procedures have shown it to be useful for improving the accuracy of the calculated

age. Statistical method of measuring the tracks has newly been introduced. Stability of the tracks should be examined much more carefully than preceding experiments. The annealing dissipation from the one end of a track to the other implies the original track form. The method looks promising in spite of all the problems. (NSA of Japan)

6447 THE CONTENT OF THORIUM SERIES ELEMENTS OF HOT SPRING WATERS IN JAPAN. 12. ON HOT SPRINGS IN THE KANTO AND CHUBU DISTRICTS. Shimokata, Kozo, Ishihara, Hiraku (Nagoya Inst. of Tech., Japan). Onsen Kagaku, 17: Nos. 3 and 4, 134-9(Mar. 1967). (In Japanese).

Determination of thorium series elements in the spring waters in the Kanto and Chubu Districts was carried out. Seventy-eight water samples were gathered, the elements were concentrated by coprecipitation with ferric hydroxide, and estimated by the thoron method. The results were as follows: The waters examined were very low in ^{220}Rn, no ^{220}Rn was detected except in Masutomi and Shitazima spring waters. The amounts of ^{228}Ra and ^{228}Th in the above 2 waters were calculated from that of ^{220}Rn. (NSA of Japan)

6448 RADIOISOTOPES AND LABELLED SALTS IN SOIL-WATER MOVEMENT. Nielsen, D. R.; Biggar, J. W. pp 61-76 of STI/PUB-133.

The behavior of tracers in several soil-water systems are briefly summarized. It should not be assumed that the tracer always goes where the water goes or a crude estimate of water movement will be found. If tracer behavior under particular conditions within the soil is accounted for, a better understanding of soil–water movement and its implications to soil science is achieved. (F.S.)

6449 ROOT-SYSTEM DEVELOPMENT. Wiersum, L. K. pp 83-96 of STI/PUB-133.

Techniques employed in studying root-system development are reviewed. Tracer techniques are indispensable when data of the performance of the different parts of the root system are required and are to be compared. Activities of different parts of the root can be compared if tracer techniques are accompanied by root-mass distribution data. (F.S.)

6450 COORDINATED RESEARCH PROGRAMME ON THE APPLICATION OF RADIATION TECHNIQUES IN STUDIES OF WATER-USE EFFICIENCY. pp 97-106 of STI/PUB-133.

The application of radiation in water-use efficiency studies is discussed. Evapotranspiration data under different climatic conditions will be obtained by using a simple weighable hydraulic lysimeter, following changes in moisture content in the soil with a neutron moisture meter, and "Penman" computations. (F.S.)

6451 RADIOMETRIC SURVEY WITH A CAR-MOUNTED INSTRUMENT IN THE SOUTHERN PART OF HYOGO PREFECTURE. Sugiyama, Tomonori; Obi, Nakamaru; Kanaya, Hiroshi (Division of Physical Survey, Hyogo, Japan). Chischitsu Chosacho Geppo, 16: 161-2(Mar. 1965). (In Japanese).

A radioactivity survey with a car-mounted scintillation counter was conducted in the southern part of Hyogo prefecture of Japan in November and December 1961. The survey area included the southern part of Hyogo, 4700 Km^2, including 3 mountains: Mt. Sanbo (1358 m), Mt. Hinakura (1047 m), and Mt. Kokubi (1024 m). Survey of radioactive material in the granitic zones was emphasized. The detection instrument was a scintillation counter with a 5 × 2 in. NaI(Tl) crystal. Results of the survey showed high radioactivity in the rocky areas, ~1.5 Km distance from the mountains, especially in the granitic area of the Rokko range which showed a radioactivity of 1600 counts/sec and 0.003% U_3O_8 content. In another investigation the radioactivity in these areas measured with a Philips Monitor reached 80 cpm and in a zone about 5 Km from these areas 45 to 52 cpm. The granites of the investigated areas usually gave a radioactivity of 600 to 700 counts/sec. Some zones showed 800 counts/sec and the northern Yamashaki stratum about 500 to 700 counts/sec. The Shiono-Alima stratum was widely distributed in the areas surveyed and the radioactivity was 500 to 650 counts/sec and in some parts 700 to 800 counts/sec. The Kobe stratum was generally lower in radioactivity, about 400 to 450 counts/sec. The Osaka stratum was lower than other areas with a radioactivity of about 400 counts/sec. (BBB)

6452 RADIOACTIVE DATING AND METHODS OF LOW-LEVEL COUNTING. Proceedings of a Symposium, Monaco, 2-10 March 1967. Proceedings Series. Vienna, International Atomic Energy Agency, 1967. 756p. $15.00; Austrian S 388.-; £5.10; F Fr 73.50; DM 60.-. (STI/PUB-152; CONF-670309). DTIE.

Fifty-seven papers on radioactive dating and methods of low-level counting are presented. Separate abstracts have been prepared for each paper. (L.C.L.)

For abstracts of individual papers see: 6270–6272, 6453–6480, 6490–6497, 6505, 6506, 6541, 6575–6582, 6621–6623, and 7080–7083.

6453 HISTORY OF RADIOCARBON DATING. Libby, W. F. (Univ. of Califronia, Los Angeles). pp 3-25 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

The development of radiocarbon dating is traced from its birth in curiosity regarding the effects of cosmic radiation on Earth. Discussed in historical perspective are: the significance of the initial measurements in determining the course of developments; the advent of the low-level counting techniques; attempts to avoid low-level counting by the use of isotopic enrichment; the gradual appearance of the environment effect due to the combustion of fossil fuel (Suess effects); recognition of the atmosphere ocean barrier for carbon dioxide exchange; detailed understanding of the mixing mechanism from the study of fallout radiocarbon; determination of the new half-life; indexing and the assimilation problem for the massive accumulation of dates; and the proliferation of measurement techniques and the impact of archaeological insight on the validity of radiocarbon dates. (auth)

6454 BRISTLECONE PINE CALIBRATION OF THE RADIOCARBON TIME SCALE FROM 4100 TO 1500 B. C. Suess, H. E. (Univ. of California, San Diego, La Jolla). pp 143-51 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

A bristlecone pine (Pinus aristata) tree-ring sequence going back some 6700 years has been established. As was shown previously by several radiocarbon laboratories, the dendrochronologically determined age of wood samples and their radiocarbon ages do not agree exactly. They may show differences of the order of several hundred years. For the period between 4100 B. C. and 1500 B. C. the radiocarbon content of some 80 bristlecone pine wood samples (i.e., an average of three measurements per century) has been determined by the La Jolla Radiocarbon Laboratory with a statistical error of less than 0.5%. If one assumes that the bristlecone pine chronology gives the correct age, then the radiocarbon content of wood samples dating from the third millennium B. C. is between 6 and 9% higher than that calculated with a half-life of ^{14}C of 5730 years. The deviation in the ^{14}C content decreases for the time between 2800 and 2200 B. C. to about 2.5%, with a maximum in the 24th century B. C. A graphic representation of the deviations and a calibration curve for the conversion of dates to bristlecone pine dates is given. Direct comparison of the radiocarbon content of historically dated samples from ancient Egypt with that of bristlecone pine wood leads to calibrated radiocarbon ages which are compatible with evidence from historical records. (auth)

6455 STUDY OF TEMPERATURES PREVAILING IN ANCIENT TIMES BY MEASUREMENT OF THE ^{18}O, ^{13}C, AND ^{14}C CONTENT OF CONCRETIONS IN CAVES. Labeyrie, J.; Duplessy, J. C.; Delibrias, G.; Letolle, R. (Centre d'Etudes Nucleaires, Saclay, France. Centre des Faibles Radioactivites, Gif-sur-Yvette, France). pp 153-60 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

The age of growing stalagmites in the Aven d'Orgnac, Ardeche was determined by carbon-14 measurements. Rainwater percolating through layers of humus dissolves carbon dioxide. Having thus become acid, it attacks the limestone through which it subsequently passes. When it reaches an underground cavity $CaCO_3$ is precipitated, resulting, under certain conditions, in the formation of stalagtites and stalagmites. The initial carbon-14 content of the $CaCO_3$ was determined by various methods, and it was found that about 65% of the carbon in the concretions examined was of atmospheric origin. It was thus possible to date the concretions. Growth rate studies were carried out mainly on a white stalagmite of very pure calcite, 2 m in length and with an average diameter of 90 mm. The age of the base was estimated to be 6500 years and the growth rate 32 mm/100 yr (or 2.5 cm^3/yr). However, the rate of growth was not constant along the entire length of the stalagmite. It was found to be virtually constant over the last 4000 years or so; over the previous 2000 years it had been declining from double the present rate. This rather sudden break of the growth pattern suggests a change in climatic conditions; there was probably increased

rainfall during the earlier period which increased the amount of $CaCO_3$ carried down by the percolating rainwater. Measurements of carbon-13 made at points along the entire length of the stalagmite also revealed substantial variations in the $^{13}C/^{12}C$ ratio during the earlier 2000-year period. Variations in isotopic composition of the oxygen in the carbonate indicate alternating warm and cold periods, which are in quite good agreement with those deduced from the study of littoral transgression. (auth)

6456 BONE ORGANIC MATTER AND RADIOCARBON DATING. Haynes, C. Vance (Univ. of Arizona, Tucson). pp 163-8 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2-10, 1967. See STI/PUB-152 and CONF-670309.

Unsatisfactory results with the carbon-14 dating of bone organic matter have caused bone radiocarbon dates to be considered unreliable. Even the so-called collagen dates are commonly erroneous for samples more than a few thousand years old. Current efforts at the University of Arizona are directed towards understanding why bone yields erroneous results, what is the nature of the contaminants, and what can be done to obtain accurate dates from bone organic matter. Bone from extinct Pleistocene animals from stratified sites with adequate geochronological control was selected for analysis. From each sample four organic fractions (humic acids, fulvic acids, soluble bone organic matter, and insoluble bone organic matter) were chemically separated and analyzed for carbon-14. The results were then compared to radiocarbon dates on associated wood or charcoal or age estimates based upon other data. Results suggest that collagen, free of humic acids, yields reliable results and is the only reliable organic fraction for dating fossil bone. Humic acids that are not removed by standard pre-treatment are a prime suspect in the contamination of "collagen" and can lead to dates that are too old as well as too young. (auth)

6457 USE OF ^{14}C OF THERMONUCLEAR ORIGIN TO STUDY THE DYNAMICS OF CARBON IN THE SOIL. Nakhla, S. M.; Delibrias, G. (CEN, de Saclay, Gif-sur-Yvette, France). pp 169-76 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2-10, 1967. See STI/PUB-152 and CONF-670309.

The nuclear explosions which have taken place in recent years have given rise to a considerable increase in the specific activity of carbon in the atmosphere and in the biosphere. The organic matter in soils which is derived from plant debris of every kind, leaves, dead branches and radicles, is thus slowly being labelled with this artificial radioactivity. It is therefore possible to use the variations in carbon specific activity to follow the different stages in the transformation of plants in the soil. The study was made on forest soil at the edge of a thinly planted wood of chestnut trees in the Paris region, and was begun in 1964. The ^{14}C measurements deal principally with decayed plant matter, the humic acids, which are soluble in alkaline reagents and can be precipitated by sulphuric acid, and the humin, which is the insoluble organic part of the alkaline reagents. In this way it has been possible to show that in this soil humin is an intermediate stage in the transformation of plant matter into humic acids, and that in every case it is more contaminated with artificial ^{14}C than are the humic acids. The time which passes between the falling of the leaves and the formation of humic acids, the final stage in the transformation of organic materials, has been found to be between four and five years, while the duration of the decomposition of a leaf into humin is about 25 years. It has also become apparent that in the layer of soil immediately above the mother-rock, the specific activity of the humic acids was not affected in 1965 by the increase due to artificial ^{14}C, which suggests that the transport time of these acids from the surface is more than 12 years. (auth)

6458 DATING SOIL LAYERS BY ^{10}Be. Moeller, P.; Wagener, K. (Hahn-Meitner-Inst. fuer Kernforschung, Berlin). pp 177-88 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2-10, 1967. See STI/PUB-152 and CONF-670309.

The main problem in dating soil layers by the cosmogenic nuclide ^{10}Be is the isolation of beryllium from big quantities of sample materials. The following chemical process was used: leaching the sample material with HCl, extraction of Be as acetylacetonate, and ion exchange on diallyl phosphate. It is thus possible to isolate $Be(OH)_2$ in a chemically pure form containing no other radionuclides. This procedure was tested by the determination of ^{7}Be accumulated in soil. The measured ^{7}Be activity corresponds well with the mean activity of ^{7}Be in rain water. Besides humic acids in soils metal hydroxides are able to concentrate Be to a large extent. Thus ^{10}Be was found in iron ore deposits containing limonite. A calculation of the ^{10}Be production rate is given and the possibility of radioactive dating with ^{10}Be using the chemical process mentioned above is discussed. (auth)

6459 ^{26}Al IN DEEP-SEA SEDIMENTS. Alder, B. (Univ., Bern); Oeschger, H.; Wasson, J. T. pp 189-95 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2-10, 1967. See STI/PUB-152 and CONF-670309.

The ^{26}Al activity of pure Al extracted from South Pacific red clay has been measured with a relative accuracy of 15%. To decide whether this ^{26}Al is mainly produced by cosmic radiation in the upper atmosphere or located in cosmic dust particles, red-clay samples were separated by chemical and physical methods into fractions of different grain size and density. The high-density (>3g/cm^3) fraction was measured and a positron activity of about half a disintegration per minute and kilogram of dry sediment was obtained. (auth)

6460 HEAVY ION TRACKS IN THE MINERALS OF THE SAINT SEVERIN CHONDRITE. Cantelaube, Y. (Laboratoire de Mineralogie du Museum d'Histoire Naturelle, Paris); Maurette, M.; Pellas, P. pp 215-29 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2-10, 1967. See STI/PUB-152 and CONF-670309.

Heavy ion tracks have been detected, after chemical treatment, in hypersthene, plagioclase and whitlockite crystals contained in the stony meteorite (amphoterite) which fell on June 27, 1966, at Saint Séverin (Charente). By studying the variations in track density with depth, the geometrical characteristics of the tracks and the uranium concentrations in the crystals, it was possible to distinguish the tracks due to heavy ions from the primary flux of cosmic radiation ($Z > 20$) from those due to fragments produced by the spontaneous fission of ^{238}U and the extinct nuclide ^{244}Pu. On the basis of the data on the variation with depth of track densities in the hypersthene, it was possible to make an evaluation of the ablation rate in the Earth's atmosphere (≈30%) – the maximum value corresponding to a spatial erosion rate of zero — as well as of the upper limit of the erosion rate in space (<0.5 cm/10^6 yr) for the minimum ablation rate. By measuring the spontaneous fission track densities in whitlockite crystals shielded from the effects of the heavy ions from the primary flux, the value of ΔT_0 was estimated, the time interval between the end of nucleosynthesis and the moment when the whitlockite crystals begin to retain the spontaneous fission tracks. The estimated value was 400×10^6 yr. (auth)

6461 RADIATION AGES AND GAS-RETENTION AGES OF CARBONACEOUS CHONDRITES AND UNEQUILIBRATED ORDINARY CHONDRITES. Heymann, D.; Mazor, E. (Univ. of Chicago). pp 239-57 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2-10, 1967. See STI/PUB-152 and CONF-670309.

Helium, Ne, and Ar were determined by mass spectrometry in 25 carbonaceous chondrites, and in 12 unequilibrated ordinary chondrites. The occurrence of primordial inert gases, and the possibility of severe diffusion losses in certain carbonaceous chondrites, leads to the following considerations: U, Th–He ages cannot be estimated for the C1 and C2 types of carbonaceous chondrites; only "minimum" $^{3}He_c$ ages can be estimated for the C1 and C2 types of carbonaceous chondrites; and $^{38}Ar_c$ ages cannot be estimated for any of the meteorites, except Karoonda. The radiation ages of the carbonaceous chondrites and of the unequilibrated ordinary chondrites (UOC), are not grossly different from those of the ordinary chondrites. However, the following trends can be noted: the ages of the C1 and C2 carbonaceous chondrites are, on average, shorter than those of the ordinary chondrites – none of the former is greater than 15 my.; and four perhaps five C2 carbonaceous chondrites, Boriskino, Cold Bokkeveld, Haripura, Nawapali, and Nogoya, may come from a single collision 0.1 to 0.6 my. ago, with the most likely date of 0.2 ± 0.1 my. There is a rough correlation between the types of carbonaceous chondrites and K – Ar ages – C1 meteorites give ages of

1 to 1.5 × 10^9 yr, C2 meteorites of 0.6 to 4.6 × 10^9 yr, and (C3 + C4) meteorites of 2 to 4 × 10^9 yr. The great majority of the UOC seem to have cooled to below 200 to 300°C some 2.5 to 4.5 × 10^9 yr ago. Among the L3 chondrites there is a rough anti-correlation between retention age and degree of recrystallization. This seems to imply that the more highly equilibrated chondrites come from greater depth inside the parent object than the UOC. (auth)

6462 DATING METHODS BASED ON THE EXTINCT RADIONUCLIDES ^{129}I AND ^{244}Pu. Kuroda, P. K. (Univ. of Arkansas, Fayetteville). pp 259-68 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB–152 and CONF-670309.

The meteorites and the Earth contain various amounts of excess fissiogenic xenon isotopes and there seems to be a simple relationship between the amounts of fissiogenic xenon and the present-day abundances of uranium. The spontaneous fission of the extinct radionuclide ^{244}Pu appears to have contributed to the inventories of the fissiogenic xenon in the meteorites and in the Earth's atmosphere. Most achondrites contain about 5 × 10^{-5} cm^3 STP ^{136}Xe/g U, while the amounts in chondrites seem to be larger than this by a factor of 2 or 3. The meteorites also contain various amounts of excess radiogenic ^{129}Xe, which in the decay product of the extinct radionuclide ^{129}I. The ^{244}Pu/^{136}Xe and ^{129}Xe decay intervals of many meteorites were found to be concordant. (auth)

6463 OPEN SYSTEM MODEL FOR URANIUM-SERIES DATING OF PLEISTOCENE SAMPLES. Rosholt, J. N. (Geological Survey, Denver). pp 299-311 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB–152 and CONF-670309.

One radioactive dating method is to use ^{230}Th/^{234}U and ^{234}U/^{238}U ratios in Pleistocene shell samples. In previous studies on uranium-series dating, the system was assumed to have been closed to the addition or removal of ^{238}U, ^{234}U, ^{230}Th and ^{226}Ra after the original incorporation of uranium in the shells. One stringent criterion for a closed system, not included in previous studies, is the determination of ^{231}Pa and a demonstration that its growth from ^{235}U gives an age concordant with that calculated for the growth of ^{230}Th from ^{234}U. Protactinium-231 has been determined in five aragonitic mollusk shells collected from elevated marine terraces in Southern California; however, none gave concordant ages for ^{231}Pa/^{235}U and ^{230}Th/^{234}U. Commonly, in mollusk shells greater than 100,000 years of age, ^{231}Pa occurs in excess of the amount required for radioactive equilibrium with ^{235}U. Based on a closed system, no age can be calculated from the ^{231}Pa/^{235}U activity ratios that have a value greater than one. Thus, samples containing excess ^{231}Pa indicate that a closed system did not exist in the shells and that, in permeating solutions, more uranium was available to the shell than was actually assimilated by the shell. An open-system model describing the migration of uranium in Pleistocene mollusk shells and in the surrounding environment is developed for uranium-series dating. Analyses of ^{238}U, ^{234}U, ^{231}Pa and ^{230}Th are required for mathematical solution of the model to determine radiometric ages extending to about 300,000 years in the past. Ages based on an open system, compared to the apparent ages that would be obtained assuming a closed system for uranium migration, indicate that aragonitic shells which do not meet the rigid criteria demanded of a closed system can be dated using an open-system model. (auth)

6464 SYSTEMATICS IN THE Pb–U–Th SYSTEMS AND MULTIPHASE ASSEMBLAGES. Wasserburg, G. J.; Steiger, R. H. (California Inst. of Tech., Pasadena). pp 331-47 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB–152 and CONF-670309.

In a study of cogenetic zircons, it was found that the measured ^{208}Pb/^{232}Th and ^{207}Pb/^{235}U ratios formed a linear array in the corresponding coupled Pb–U–Th diagram which has an intersection on the concordia curve at approximately the same time point as determined by the coupled ^{206}Pb/^{238}U–^{207}Pb/^{235}U systems. The second point of intersection does not lie on the concordia curve. Since this may be due to the variation in the Th/U ratio in the natural separates, an investigation of the Th and U distribution in single crystals was made using an electron microprobe. Large variations in the concentration of these elements within single crystals were found as well as variation in the Th/U ratio. The theoretical aspects of a multiphase system with variable Th/U ratios and U concentrations is presented and the degree of discordance in the Pb–U systems is discussed as well as possible interpretations of the Pb–U–Th systems. These results indicate that the Pb–Th system in conjunction with the Pb–U system may provide an additional independent dating method and a means of understanding discordance in natural systems. (auth)

6465 STUDY OF MARINE TRANSGRESSIONS ON A PACIFIC ATOLL BY MEANS OF ^{14}C AND THE ^{234}U/^{230}Th RATIO. Labeyrie, J.; Lalou, C.; Delibrias, G. (Centre d'Etudes Nucleaires de Saclay, France. Centre des Faibles Radioactivites, Gif-sur-Yvette, France). pp 349-58 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB–152 and CONF-670309.

The last eustatic maximum of +3 m is dated at –3000 ± 58 yr, the 0 m level at –5000 ± 500 yr, the –7 m level of the eustatic maximum of the last interglacial at –100,000 ± 20,000 yr (re-exceeded 8000 yr ago) and finally another eustatic maximum level, corresponding to a previous interglacial, at –400,000 ± 50,000 yr. This level was re-exceeded 200,000 ± 40,000 yr ago. By dating the subjacent basalt, it was possible to evaluate the minimum average subsidence rate of the atoll. The value obtained can be used to correct the above data. (auth)

6466 INDIVIDUAL AGE DETERMINATIONS OF ZIRCONS FROM GRANITIC ROCKS BY MEANS OF THE ^{207}Pb/^{206}Pb RATIO, ZIRCONS FROM THE QUINTIN GRANITE, COTES DU NORD, FRANCE. Roubault, M.; Coppens, R.; Kosztolanyi, Ch. (Centre de Recherches Radiogeologiques, Nancy). pp 359-70 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB–152 and CONF-670309.

Zircons in rocks may be inherited from an older formation. Zircon age measurements are generally carried out on several thousand individual zircons, and may thus represent averages. Another drawback is that chemical treatments are liable to introduce traces of nonradiogenic lead. To avoid these difficulties, individual zircons in the solid state were studied without subjecting them to a chemical preparation, and individual age determinations on the basis of the ^{207}Pb/^{206}Pb ratio were made. With this method the zircon crystal is fixed to the filament of a mass spectrometer source by a mixture of orthophosphoric and hydrofluoric acid. The first of these acids is an effective agent for cementing the solid sample to the metal filament. The second attacks the zircon to produce silicon tetrafluoride SiF_4; volatilization of the latter, together with the water vapor, leaves behind a spongy surface. By using this method it has been possible to obtain excellent lead spectra with a single zircon crystal (weighing about 0.005 mg and containing 10^{-7} g of lead). The main results so far obtained are given. In one case, a rock whose age had been established by reference to geological considerations or by conventional geochronological measurements was found to contain zircons of the same age. Zircons can also be much older than the rock and provide information on periods preceding its formation. The method has been applied to zircons found in Quintin granite for which two distinct formation periods — 310 to 340 and 260 to 300 my — had been determined by conventional geochronological measurements. Forty measurements were made, 14 of which were rejected because of the presence of a small quantity of ^{204}Pb. An age histogram of the zircons revealed the existence of two major populations — 248 to 278 and 301 to 336 my — corresponding to the periods indicated above. It also revealed that the ages of some zircons varied between 350 and 365 my and that one zircon was 391 my old. Irrespective of how the older ages are interpreted, this agreement between the ages of the two groups of minerals (young zircons and muscovite on the one hand, and older zircons and biotites and feldspars on the other) must be regarded as a noteworthy result which provides further evidence of the very long duration of granitization phenomena. (auth)

6467 THE GEOCHRONOMETRIC METHOD OF TOTAL LEAD APPLIED TO THE GEOLOGICAL STUDY OF THE MASSIFS OF MONT BLANC AND THE AIGUILLES ROUGES (THE FRANCO-SWISS ALPS). Laurent, R.; Chessex, R.; Delaloye, M. (Inst. de Mineralogie, Geneva). pp 371-84 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB–152 and CONF-670309.

The method used for quantitative measurement of U, Th and Pb in a zircon concentrate is described including the various procedures used to obtain high sensitivity, good reproducibility and high speed in the detection of these elements in trace amounts. The limitations, advantages and difficulties of X-fluorescence as applied to this particular case are discussed on the theoretical level, and then illustrated by practical examples. The Larsen method, applied systematically to all the massifs of the Alpine range, is put into practice on one of them. The following conclusions can be drawn from the results obtained: a first orogenic cycle seems to go back to the Upper Precambrian, and ages of more than 600 my have been obtained; the intrusive granites were laid down during the Hercynian orogenesis (pre-Stephanian phase) with the dispersion of the results partly attributed to the effects of the Alpine orogenesis and of the late Hercynian phase; the gneiss of sedimentary origin (paragneiss and endomigmatites) give ages of between 450 and 600 my. (auth)

6468 DATING OF GLACIERS BY ^{210}Pb. Crozaz, Ghislaine (Univ. Libre, Brussels). pp 385-93 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

A method is described of dating neve and ice, based on the radioactive decay of ^{210}Pb or RaD ($T_{\frac{1}{2}}$ = 22 yr). Two techniques have been developed to measure the very low activities of ^{210}Pb (0.1 to 5 dpm). One uses a semiconductor detector to take spectral measurements of the α-activity of ^{210}Po labeled with ^{209}Po; the other is based on measurement of the β-radiation of ^{210}Bi by a proportional counter. The method has been applied to several sections of neve taken in the Antarctic, in Greenland and on an Alpine glacier, each covering a period of more than 100 yr. The results show that in the Polar regions the neve behaves as a closed system from the moment of precipitation, the ^{210}Pb dating this moment. The accumulation rates deduced from the ^{210}Pb distribution as a function of depth are in excellent agreement with those of other methods. In temperate glaciers, because of the homogenization of the neve caused by percolation of the melting water, the event dated by the ^{210}Pb is the transformation of the neve into compact ice. The ^{210}Pb ages obtained with ice samples from the ablation area of the Kesselwandferner (Austrian Tyrol) are in good agreement with current ideas on glacier dynamics. Comparison of the ^{210}Pb and fission product concentrations has revealed no evidence of the artificial production of ^{210}Pb by the explosion of nuclear devices. With samples of 2 kg, this method can be used to date ice with an age of 100 yr in the Antarctic and more than 120 yr in Greenland and in temperate zones. (auth)

6469 DIRECT DATING OF FOSSILS BY THE HELIUM–URANIUM METHOD. Schaffer, O. A. (State Univ. of New York). pp 395-402 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

The He–U method has been found to be applicable to the dating of fossil carbonates. This method furnishes a new dating technique particularly applicable to the Pleistocene and the Tertiary periods, especially the Late Tertiary, for which other methods of age dating either fail or are difficult to correlate with the fossil record. The method has been checked for possible losses of helium and uranium from or to the surroundings. It has been found that, while a calcite lattice does not appear to retain helium, if the lattice is aragonite there is good evidence that helium leakage is not a problem. This is true at least for times up to 20 my. For corals where the uranium is apparently uniformly distributed within the lattice as a trace element, the uranium does not exchange or undergo concentration changes. As a result aragonite corals yield reliable He–U ages. On the other hand, the uranium in mollusk fossils is apparently mainly in the grain boundaries and is not always a tight system as far as uranium exchange or concentration changes are concerned. To obtain a reliable age for a mollusk one needs additional evidence to ensure lack of changes in uranium concentration. If the measurement of U and He is combined with ^{238}U, ^{234}U and ^{230}Th determinations, it appears that many mollusk shells will also be datable by the method. The resulting evidence for secular equilibrium in the ^{238}U chain is good evidence for a closed system as far as U concentration changes are concerned. (auth)

6470 INFLUENCE OF EXPERIMENTAL FACTORS ON DATING NATURAL AND MAN-MADE GLASSES BY THE FISSION TRACK METHOD. Kaufhold, J.; Herr, W. (Univ. of Cologne). pp 403-13 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

In age determination work by counting fission tracks the precision, besides the statistical counting error of spontaneous and induced tracks, largely depends on exact determination of the neutron dose and close maintenance of etching conditions. Slight variations in temperature and concentrations of etch batches may lead to considerable deviations. By dating several "Early Victorian" U-stained glasses the authors discovered the fact that the spontaneous fission decay constant $\lambda_{sp.f.}$ is still not known with sufficient accuracy. Since an age of $\stackrel{<}{=}$150 yr can be inferred from the style of these glasses, the most probable value of $\lambda_{sp.f.}$ should lie closely to 8×10^{-17} yr^{-1}. In establishing the coincidence of two geological events the uncertainty of $\lambda_{sp.f.}$ may be less important. The agreement in the age of moldavites $(14.9 \pm 1.6) \times 10^6$ yr and the Ries Crater glass $(14.9 \pm 1.5) \times 10^6$ yr was confirmed. (auth)

6471 OBSERVATION OF FOSSIL α-PARTICLE RECOIL TRACKS AND THEIR IMPLICATIONS FOR DATING MEASUREMENTS. Huang, W. H.; Maurette, M.; Walker, R. M. (Washington Univ., St. Louis). pp 415-29 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, France, Mar. 2-10, 1967. See STI/PUB-152 and CONF-670309.

Samples that have been etched to reveal fossil fission tracks contain an accompanying high density of shallow etch pits that are clearly visible using phase contrast optical microscopy. A number of lines of evidence demonstrates conclusively that these shallow pits are produced by the heavy recoil nuclei accompanying α-decay of U and Th impurities. Measurement of the density of fossil α-recoil tracks, coupled with measures of the track densities induced by separate slow and fast neutron irradiations, gives a new track dating method. The new method is somewhat more complicated than the previously discovered fission track method, but is some 3×10^3 times more sensitive. Because of this enhanced sensitivity, the α-recoil method of dating has a number of potential interesting applications. It should prove particularly useful in connection with the problem of extinct isotopes in meteorites. (auth)

6472 ABSOLUTE DATING OF MOUNTAIN BUILDING EVENTS. Adams, J. A. S.; Burchfiel, B. C.; Sutter, J. F. (Rice Univ., Houston, Tex.). pp 453-62 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

In the past year over fifty absolute ^{40}K/^{40}Ar whole-rock and mineral age determinations have been made in the laboratory to elucidate some of the time relationships of the orogenic or mountain building movements in southern Nevada and southeastern California in the United States of America. Detailed field mapping revealed a number of igneous rocks crosscut by thrust faults or crosscutting thrust faults. The absolute ages demonstrate unambiguously that faulting in the Clark Mountains and the Hunter Mountains (150 miles apart) was separated in time by at least fifty million years. It is noteworthy that the Clark Mountain orogenic event falls in geologic time almost exactly mid-way between the classical Nevadan (conventionally 135 my) and classical Laramide (conventionally 63 my) orogenies. In several cases it was also possible to collect blastomylonite — material right at the fault plane that had been crushed, metasomatized, and recrystallized. Carefully selected mylonites, containing quartz with no evidence of straining, yielded ages within the bracket provided by the minimum and maximum ages from crosscutting relationships. The ^{40}Ar determinations were made by isotope dilution with a conventional mass spectrometer. The potassium was determined gravimetrically as well as by flame atomic absorption. By extending such techniques or orogenic belts in other parts of the world, it now appears possible to determine whether mountain building occurs as a more or less continuous process in geologic time, or whether it is confined to rather short periods in geologic time corresponding to the great mountain building revolutions postulated in classical geology. (auth)

6473 PROBLEM OF EXCESS ^{40}Ar IN VOLCANIC ROCKS. Damon, P. E.; Laughlin, A. W.; Percious, J. K. (Univ. of Arizona, Tucson). pp 463-81 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of

Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB–152 and CONF-670309.

Recent investigations have demonstrated that under favorable conditions it is possible to obtain reasonable ages for Pleistocene volcanic rocks by the K–Ar method. Experimental precision in determining the ratio of radiogenic argon-40 to potassium-40 is not necessarily the ultimate limitation on the meaningful dating of these rocks. This limit will probably be set in many cases by the phenomenon of excess argon-40 in minerals and the inheritance of argon-40 in xenolithic materials. It is now apparent that some level of excess argon-40 in minerals from intrusive environments is a ubiquitous phenomenon. Measurements in this laboratory indicate typical levels of around 10^{-10} moles/gram for the major rock-forming feldspar minerals. Retention of only 1% of this amount presents a significant limitation to dating of late Pleistocene volcanic rocks. Measurements on large phenocrysts from volcanic rocks demonstrate that this amount can be retained (1 to 5×10^{-12} moles/gram). The critical factors in outgassing of volcanic materials are the cooling rate and the diffusion parameters. Fine-grained minerals are most suitable. Rapidly chilled boundary zones should be avoided. Measurements on cogenetic nonpotassic-potassic minerals can aid to the evaluation of errors due to the phenomenon of excess argon-40. (auth)

6474 ARGON AND POTASSIUM IN MINERAL FRACTIONS OF THREE ULTRAMAFIC ROCKS FROM THE BALTIC SHIELD. Kirsten, T.; Mueller, O. (Max-Planck-Institut fuer Kernphysik, Heidelberg). pp 483-98 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB–152 and CONF-670309.

Three xenolithic ultramafic rocks from Nittis and Montsche Tundra, Kola peninsula, were divided into 15 fractions using magnet separation and heavy liquids. $^{40}Ar_{rad}$ and ^{4}He were measured in each fraction by mass spectrometry. The potassium contents were estimated by neutron activation and flame photometry. The correlation between $^{40}Ar_{rad}$ and K, observed in similar samples in a previous work, was checked, using better separated fractions with larger differences in potassium. Diffusion measurements were also carried out on the whole rock samples to determine how the argon was bound. $^{40}Ar_{rad}$ and K are correlated in all three samples. The $^{40}Ar_{rad}/K$ ratios in different fractions vary much less than the potassium contents themselves, and are approximately represented by isochrons of 3.4 ± 0.2; 3.9 ± 0.6 and $10.7 \pm 0.6 \times 10^{9}$ yr for the three rocks. However, the fractions high in plagioclase content show lower $^{40}Ar_{rad}/K$ ratios as can also be seen from previous work. The first two ages range near the age of the Montschegorsk pluton (3.4×10^{9} yr) from which the samples were obtained. The explanation of the 10.7×10^{9} yr "age" is complicated because of the K–Ar correlation. The Earth's mantle can be older than the crust, but a limit of 7×10^{9} yr for the age of the Earth is imposed by the present isotopic composition of natural uranium. The diffusion experiments show that the radiogenic argon in this sample consists of two components: 76% of the radiogenic argon can be released up to 1100°C with a maximum at 800°C, but 24% is still bound at 1250°C and could be released only by melting the sample. The different components can be related to in situ radiogenic argon and dissolved excess argon in one or more mineral components. Nevertheless, the K–Ar age is still greater than 8×10^{9} yr even using one argon component in the age calculation. A process of argon inclusion which is correlated by some means with potassium content should be considered. Experimentally, both the K–Ar correlation and the high potassium–argon ratios were confirmed. The solution of the discrepancy is still pending. (auth)

6475 DEVELOPMENT AND RECENT APPLICATIONS OF THE Re/Os DATING METHOD. Herr, W. (Univ. of Cologne); Woelfe, R.; Eberhardt, P.; Kopp, E. pp 499-508 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB–152 and CONF-670309.

Using isotope dilution techniques combined with neutron activation analysis the Re/Os and $^{187}Os/^{186}Os$ ratios in a larger number of sulfide minerals, especially molybdenites, were determined. Iron meteorites were also studied. As the ratios vary sufficiently, the $^{187}Re/^{187}Os$ method has proved to be applicable and to be a valuable tool for dating sulfidic ore deposits. The results on 17 minerals are in agreement with those obtained by conventional methods. The limits of the ^{187}Re β^{-}-decay constant were narrowed further, and a possible application for the estimation of the age of the galaxy is considered. (auth)

6476 GEOLOGICAL MEANING OF Rb–Sr AGE RESULTS AS STUDIED ON SAMPLES FROM THE CENTRAL ALPS. Jager, E.; Niggli, E. (Univ. of Bern). pp 509-14 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB–152 and CONF-670309.

The Rb–Sr method has been applied to many rocks from the Central Alps. The analyzed samples were selected from regions of different degrees of Tertiary Alpine metamorphism: from the zone where petrologically no metamorphism can be detected to the kyanite-staurolite and sillimanite zones. Biotites give pre-Alpine ages of about 300 my in the zone of lowest degree of metamorphism. In the stilpnomelane zone the transition from pre-Alpine to young Alpine ages is found. In this zone the type of rock influences the age results on the biotite; more acid rocks tend to give younger biotite ages. There exists a correlation between triclinity of the K-feldspars and the biotite ages; rocks with triclinic K-feldspars give young biotite ages, monoclinic feldspars are associated with biotites of pre-Alpine ages. In the zone of Alpine kyanite and staurolite no biotite of pre-Alpine age was found. In this zone of young ages the type of rock has no influence on the biotite age result. The young biotite ages show a regular regional distribution, ranging from 25 my in the East (Bergell) to 11 my in the West (Simplon). These data are explained as ages of cooling to a certain temperature after the last main phase of Alpine metamorphism. These ages do not represent the time of a tectonic or metamorphic phase. In the area of the youngest biotite ages biotites from fissures give the same age result as the biotites from the country rocks. Muscovites are less influenced by the Alpine metamorphism than the biotites. Several pre-Alpine muscovite ages were found in the chloritoid zone. The young Alpine muscovite ages are higher than the ages on biotite from the same rock. For different regions with different age results the age difference is usually constant, 8 my. The young muscovite ages are explained as ages of cooling to a certain temperature; this temperature is higher for muscovite than for biotite. The constant age difference points to a constant cooling rate. Even in the zone of highest metamorphism only pre-Alpine total rock ages were found, except on Alpine pegmatites. (auth)

6477 DEVELOPMENT OF THE METHOD OF MEASURING THE AGE OF ROCKS BASED ON THE $^{176}Lu/^{176}Hf$ RATIO. Boudin, A. (Univ., Libre, Brussels). pp 515-22 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB–152 and CONF-670309.

The pair hafnium-176/lutetium-176 can be used to date certain relatively widespread rare-earth ores. The authors undertook the development of methods of chemical analysis of Lu and Hf and of isotopic analysis of Hf which can be used for routine measurements of quantities of ore of the order of 1 g. The Lu is measured by flame photospectrometry using atomic absorption. In its present stage of development this method can be used to measure concentrations of the order of 10 ppM of Lu without serious interference from other rare earths. Mass spectrometry of Hf has been developed to measure the principal isotopic ratios using an amount of Hf of the order of 1 μg extract of the ore, with a relative precision of about ±1%. This same method can be used to measure the Hf concentration on the scale from 0.1 to 1 ppM, using the method of isotopic dilution with a stable isotope. A fast activation analysis method has also been developed for Hf; it is based on the reaction $^{179}Hf(n,\gamma)$ $^{180m}Hf(T_{\frac{1}{2}} = 5.5$ hr), thus making the chemical separation of the zirconium unnecessary. These methods are at present being applied to a series of rare-earth ores dated by the Pb/U isotopic ratios. (auth)

6478 THERMOLUMINESCENCE DATING OF ANCIENT CERAMICS. Aitken, M. J.; Fleming, S. J.; Zimmerman, D. W. (Oxford Univ.). pp 523-30 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB–152 and CONF-670309.

Absolute dating by the thermoluminescence technique, rather than the relative dating previously aimed for, is possible if allowance is made for radiation attenuation effects. To do this the thermoluminescence measurements are made on crystalline

inclusions separated out from the fine-grained clay matrix. These inclusions, which are usually quartz, are large enough for their average radiation dose from alpha particles originating in the clay matrix to be negligible. Since the uranium and thorium are carried predominantly in the clay matrix, the natural thermoluminescence acquired by the inclusions comes effectively only from the beta and gamma contributions. A preliminary test programme on known-age pottery fragments dating back to 8000 B. P. has given correct absolute ages to within ±20%. (auth)

6479 GEOLOGIC DATING BY ELECTRON SPIN RESONANCE. Zeller, E. J. (Univ. of Kansas, Lawrence); Levy, P. W.; Mattern, P. L. pp 531-40 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB–152 and CONF-670309.

A new method of geologic age determination using electron spin resonance to measure trapped charge in minerals has been developed and tested. The method is based upon the assumption that the trapped charge accumulation in crystals is a function of the total radiation dose to which they have been exposed. Factors controlling the origin and retention of the charge are reviewed and the principles of electron spin resonance are described. The method has been tested by dating apatite crystals from Durango, Mexico. This sample shows two ESR absorption peaks which increase in intensity when the crystals are irradiated with gamma rays. The total radiation dose which the crystals have received during their geologic history is determined from the natural ESR signal and the signal growth curves after artificial irradiation. Counting measurements of the radioactive impurity content of the sample were used to compute the annual natural radiation dose. The age calculated from the ESR and counting data is 2 to 4×10^6 yr. Annealing measurements indicate that the ESR signals are associated with traps capable of retaining charges in excess of 4×10^6 yr. Although the apatite samples have not been independently dated, the geology of the Durango region puts an upper limit on their age as approximately 3×10^7 yr. (auth)

6480 RAPID ISOTOPE ENRICHMENT OF GASES BY THERMAL DIFFUSION FOR NUCLEAR DATING. Verhagen, B. Th. (Univ. of Witwatersrand, Johannesburg). pp 657-72 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB–152 and CONF-670309.

Considerable interest has developed in the use of thermal diffusion as a means of increasing the sensitivity of carbon-14 and tritium detection for dating purposes. Systems developed by a number of workers for the enrichment of tritium in the gaseous phase are briefly reviewed. Thermal diffusion columns are capable of great accuracy of enrichment, as the operating conditions can be closely controlled. Hot-wire columns have low transport of enriched material, and require high hot-wall temperatures. Greater rapidity of enrichment can be obtained with concentric tube columns, in which the hot-wall temperature can be kept low enough to permit the use of dissociable gases. Single-stage and multi-stage enrichment of tritium in hydrogen are discussed in relation to different tritium levels and counter capacities, as well as the advantages of static and flow systems. Experimental results are presented on two systems for routine operation: giving an enrichment of 68 times in 8 hr with a final yield of 1 at 1 STP hydrogen; and giving enrichments of six times in 4.5 hr with a yield of 10 at 1 STP hydrogen. The applicability of multi-stage enrichment to and the use of concentric tube columns in the enrichment of ^{14}C in carbon monoxide are briefly discussed. (auth)

Meteorology

Refer also to abstracts 6500, 6505, and 6506.

6481 (BMwF-FBK-67-73) EXPERIMENTE ZUR SCHADSTOFFAUSBREITUNG AUS HOCHGELEGENEN QUELLEN. (Diffusion Experiments from an Elevated Continuous Point Source). Klug, W.; Markusch, H. (Technische Hochschule, Darmstadt (West Germany). Institut fuer Meteorologie). Mar. 31, 1967. 55p. (In German). Dep.

A series of diffusion experiments from an elevated point source were performed. The experimental facilities and the results from meteorological and concentration measurements are given. The results are compared with those from previous experiments. (auth)

6482 (FOA-4-4296-23) FRAKTIONERINGSFENOMEN I AKTIVITET FRAN EN UNDERJORDISK KAERNEXPLOSION. (Radioactive Fractioning Phenomena From an Underground Nuclear Explosion). Persson, G. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Apr. 1967. 17p. (In Swedish). Dep.

Activity from the Russian underground nuclear explosion of December 18, 1966, increased in the northernmost parts of Sweden on land and in the ground air between December 22 and 30. Trajectory studies confirmed the fallout picture. Gamma spectrometric and radiochemical studies showed the increase in the activity of ^{89}Sr, ^{90}Sr, ^{137}Cs, and $^{140}Ba-^{140}La$. (tr-auth)

6483 (SC-DC-67-2339) AUTOMATED METEOROLOGICAL MEASUREMENT SYSTEM. Church, H. W.; Luna, R. E.; Reed, J. W. (Sandia Corp., Albuquerque, N. Mex.); Booth, H. G. (Environmental Science Services Administration, Las Vegas, Nev. Air Resources Field Research Office). Nov. 1967. Contract AT(29-1)-789. 16p. (CONF-671205-1).

From Symposium on Theory and Measurement of Atmospheric Turbulence and Diffusion in the Planetary Boundary Layer, Albuquerque, N. Mex.

An automated meteorological measuring system which will supply high quality micrometeorological measurements in the atmospheric boundary layer is described. The station which will be used for obtaining data for operational and research problems of pollutant dispersal predictions will include two towers; a 460 m tower at Jackass Flats and a 150 m tower in Yucca Flats. The towers are available and computer and electronics designs appear to have reached a point where relatively small, reliable, and tested components are available at reasonable cost to perform the required functions with possible surplus capacity. (F.S.)

6484 (SC-DC-67-2343) TURBULENCE DATA FOR USE IN HAZARD ANALYSES. Luna, R. E. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1967. Contract AT(29-1)-789. 25p. (CONF-671205-2). Dep. CFSTI.

From Symposium on Theory and Measurement of Atmospheric Turbulence and Diffusion in the Planetary Boundary Layer, Albuquerque, N. Mex.

Assessment of the hazard resulting from the random release of a dangerous aerosol to the atmosphere requires a model for predicting transport and turbulent diffusion of the aerosol and a statistical representation of the parameters which appear in the model. The occurrence statistics of turbulence and wind speed parameters which appear in the generalized equations describing turbulent diffusion are presented. The parameters, plotted in a log-probability format, are σ_A, the standard deviation of the wind direction, the product $\sigma_A U$ (where U is mean wind speed) and $\sigma_A^2 U$. The occurrence statistics are based on two years of wind speed and direction observations made at White Sands Missile Range and hence are only strictly applicable to that site. However, the data present a useful guideline for estimating magnitude and variability of these quantities at other sites where measurements accumulated over a comparable time span are not available. (auth)

6485 EFFECT OF THE TUNGUSKA METEOR AND SUNSPOTS ON RADIOCARBON IN TREE RINGS. Lerman, J. C.; Mook, W. G.; Vogel, J. C. (Univ. of Groningen, Netherlands). Nature (London), 216: 990-1(Dec. 9, 1967).

This meteor fell in Siberia on June 30, 1908, and the apparent absence of a crater is puzzling. Analyses of the soil in the region indicate nickeliferous iron and silicate globules. The possibility has been discussed of the associated phenomena being produced by the annihilation of antimatter in the atmosphere, and measurements have been attempted of the increase in atmospheric ^{14}C which should have been produced by the neutrons generated in this process and recorded in tree rings. These measurements have also been discussed in relation to the solar activity cycle. New measurements of radiocarbon in tree rings, with higher accuracy are described. Results show no significant deviations which could be correlated either with the meteor or with the sunspot cycle. The experimental method adopted is described. (UK)

6486 EFFECTS OF THIRD COMMUNIST CHINESE NUCLEAR TEST. I. FALLOUT OF STRONG RADIOACTIVE PARTICLES DETECTED IN NIIGATA. Kosaka, Takdo; Takizawa, Yukio (Niigata Univ., Japan). Niigata Igakkai Zasshi, 80: 456-8(Aug. 1966). (In Japanese).

Communist China carried out its third nuclear test in May 1966 in the air over the western part of mainland China. The fall of highly radioactive particles due to this test was detected and the state of their falling and the nature of the particles were investigated. In the collection of samples, 90 glass sheets (30 × 40 cm) were appropriately placed and the particles collected by means of filter paper. The falling of highly radioactive particles appeared rapidly after the test compared with the previous one, and the fallout was large in amount and of a single passage. The intensity of radioactivity of individual particles also tended to be high. A

microscopic examination showed the diameters of particles to be in the vicinity of 10 μ. These phenomena are considered as strongly influenced by the atmospheric currents as well as by the nature of the nuclear test. (NSA of Japan)

6487 QUANTITATIVE ASPECTS OF ENVIRONMENTAL MONITORING IN CANADA. Mawson, C. A. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 261-73 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

The development of an environmental radiation monitoring program in Canada is described. Methods of measuring the radioactivity of air, ground waters, soils, and surfaces in the vicinity of nuclear installations are discussed. (L.C.L.)

6488 METHODS OF FALLOUT MEASUREMENTS USED IN INDIA. Rangarajan, C.; Mishra, U. C. (Atomic Energy Establishment, Trombay, India). pp 287-300 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

Since early 1956 environmental radioactivity measurements have been made of Indian ground level air, rainwater and dust, milk and foodstuffs consumed by humans, human bone, and surface soil. The sampling and counting procedures are described. Results are tabulated. (L.C.L.)

6489 AIRBORNE RADIOACTIVITY OVER THE INDIAN OCEAN. Bhattathiri, P. M. A.; Unni, C. K.; Doshi, G. R.; Gogate, S. S.; Sreekumaran, C. (Atomic Energy Establishment, Trombay, India). pp 301-7 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

Radon and thoron activities over the Indian Ocean were measured during 1962 to 1963 to determine the levels of radioactivity in the air and to determine how these levels could be used to measure air movements in the costal regions of India. Sampling and measurement procedures are described, and the results tabulated. The activities in air over the Bay of Bengal were greater than those in air above the Arabian Sea. Further measurements are recommended to establish the effect of meteorological conditions on these radioactivities. (L.C.L.)

6490 ORIGIN AND EXTENT OF ATMOSPHERIC ^{14}C VARIATIONS DURING THE PAST 10 000 YEARS. Stuiver, M. (Yale Univ., New Haven). pp 27-40 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

The detailed ^{14}C analysis of sediments flooring three lakes: Rogers Lake, Conn., in the United States of America, Lake Victoria in Africa, and Lake Yueh Tan in Formosa is reported. The lakes were chosen from widely different latitudes to avoid synchronous variations induced by local climatic changes. Two of the lakes, Rogers Lake and Lake Victoria, show a surprisingly steady sedimentation rate. When corrected for changes in time scale, known from three-ring studies, the absolute sedimentation rates for both lakes appears to have been constant for the past 6000 calendar years. The sedimentation rate study affirms the change in time scale observed in ^{14}C ages of tree rings and Egyptian samples of known ages around 2500 B. P. In addition, important synchronous changes are lacking in the sedimentation rates of all three lakes between 2500 and 10,000 years B. P. This implies that there have been neither important variations in sedimentation rates due to world-wide climatic changes nor drastic changes in the ^{14}C time scale during this time span. The results strongly suggest that the rising trend in ^{14}C concentration, determined from tree-ring studies as occurring between about 2500 years B. P. and at least 10,000 years B. P. The present ^{14}C results from lake sedimentation rates agree to a remarkable extent with the hypothesis of a "super-quiet" sun (a sun without the convection pattern associated with the sunspot cycle) as being the cause for glacial intervals. (auth)

6491 ^{14}C CONCENTRATIONS IN ENVIRONMENTAL MATERIALS AND THEIR TEMPORAL FLUCTUATIONS. Walton, A. (Univ. of Glasgow); Baxter, M. S.; Callow, W. J.; Baker, M. J. pp 41-7 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

Artificial ^{14}C in the atmosphere is produced in nuclear reactions ($^{14}N(n,p)^{14}C$) between nitrogen atoms in the air and neutrons liberated in the explosion of nuclear devices. Consequently ^{14}C concentrations in the Earth's dynamic carbon reservoir have been substantially increased as a result of atmospheric testing during the past decade. Atmospheric carbon dioxide is the ultimate source of the carbon in all living organisms, so that fluctuations in the radiocarbon concentration of the former would be expected to produce parallel variations in the latter. This correlation between ^{14}C concentrations of atmospheric and plant materials has been investigated. To measure the ^{14}C activity of plant materials of recent but known age a number of spirit samples have been analysed. It was assumed that the ^{14}C concentrations of samples would be indicative of the activity of the grain during the growth period. Fluctuations in atmospheric ^{14}C concentrations during and after periods of nuclear-weapons testing have been followed by many workers. Individual data are available from several different latitudes, and results have been selected for comparison purposes. Data show that there is a general correlation between the ^{14}C concentrations of spirits and atmospheric CO_2 samples with the result that the year of manufacture of the spirits is predictable. The "Suess effect" and the "bomb effect" are considered in the light of this correlation. (auth)

6492 VARIATIONS IN THE PRODUCTION OF COSMOGENIC RADIONUCLIDES. Aegerter, S. K.; Loosli, H. H.; Oeschger, H. (Univ., Bern). pp 49-55 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

A brief review of data concerning the time variations of ^{14}C concentrations in atmospheric CO_2, and their various interpretations, is given. The possible processes which can affect the $^{14}C/^{12}C$ ratio in the atmosphere and in the biosphere are discussed, in particular changes in the production rate and the exchange rate between different reservoirs. It is shown that a change in one of these processes has different consequences for different isotopes, depending on their geochemical behavior. Based on this fact, experiments are proposed and described which make it possible to decide which of the two generally considered processes is mainly responsible for the observed ^{14}C variations. The preliminary results obtained were that tritium deposition in Greenland shows variations which can be explained by the varying solar activity, variations are also observed for the ^{32}Si deposition in the ice layers on the Jungfraujoch, and the ^{81}Kr activity of atmospheric krypton is found to be not higher than twice the expected value. (auth)

6493 EFFECT OF INDUSTRIAL FUEL COMBUSTION ON THE ^{14}C LEVEL OF ATMOSPHERIC CO_2. Houtermans, J. (Scripps Institution of Oceanography, La Jolla, Calif.); Suess, H. E.; Munk, W. pp 57-68 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

As was previously noticed in 1953 by Suess, the radiocarbon content of atmospheric CO_2 was slightly lower in the 20th century (before the increase in the carbon-14 level due to the addition of artificial ^{14}C) than at the time before the beginning of the industrial revolution in the 19th century. An exact knowledge of the magnitude of this effect is of interest in connection with the question of the rate of isotope exchange between atmospheric CO_2 and the bicarbonates of the oceans. However, the radiocarbon level in the CO_2 of the atmosphere is also subject to natural fluctuations caused by a variable cosmic-ray production rate of carbon-14. To investigate this the authors have cross-correlated sunspot numbers (as indicators of cosmic-ray activity) with the carbon-14 level in wood, and have detected a significant coherence between the two time series. The observed coherence permits an extrapolation of the natural carbon-14 values beyond the time of the beginning of artificial combustion of fossil fuel, around 1880. The results show that the observed small decrease in the carbon-14 level is somewhat affected by the increase of the production rate of carbon-14, as a consequence of relatively low solar activity during the preceding decades. The effect of industrial fuel combustion upon the carbon-14 level of the atmosphere can then be estimated for the Northern Hemisphere to be in the vicinity of –3%. (auth)

6494 VERY HIGH ^{14}C ACTIVITY IN ABISKO, SWEDEN DURING SUMMER, 1965. Olsson, I. U.; Stenberg, A. (Uppsala Univ.). pp 69-78 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB–152 and CONF-670309.

During the summer of 1965 there was remarkably high ^{14}C activity in the atmosphere at Abisko in the northern part of Sweden. The ^{14}C activity over Spitsbergen was much lower and the increase started much later. The excess at Abisko was more than 30,000‰ of the standard and was decreasing very rapidly. Samples collected at the end of April show the authors' measured maximum. Ten days earlier the intensity was about 760‰ and ten days later about 7000‰ above the standard. Twenty days after the large peak the excess was about 2000‰. In the beginning of September the excess was still a little more than 1000‰ above the standard. The Abisko values indicate a second peak in July. The second peak is, however, only about 1300‰ over the standard. The values for the winters before and after the summer of 1965 were about 760 and 700‰, respectively. In May 1966 the excess in Abisko was still below 750‰. The international ^{14}C standard, 95% of the activity in 1950 of oxalic acid, from the National Bureau of Standards (NBS) in Washington, D. C., was used as the reference sample. The samples were collected by absorption in NaOH solution in a tray with an open surface of about 900 cm^2. Each collection period was three or four days. The samplers were mounted in the open air a few meters above ground level. From the beginning of April to the end of November 1965 about 15 samples were measured from Abisko but only five from Spitsbergen. A possible explanation of the activity peak is contamination due to special ^{14}C experiments in Abisko. (auth)

6495 AN ANALYTIC MODEL OF ^{14}C DISTRIBUTION IN THE ATMOSPHERE. Schell, W. R.; Fairhall, A. W.; Harp, G. D. (Univ. of Washington, Seattle). pp 79-92 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB–152 and CONF-670309.

An analytic model describing carbon-14 distribution in the atmosphere has been derived. The model assumes that the atmosphere and ocean comprise a closed system with respect to carbon-14 exchange and that the total carbon-14 content of the system is constant during the period under consideration. Using these basic assumptions, the equilibrium of carbon-12, -13, and -14 dioxide in the atmosphere and ocean is evaluated. Changes in ocean temperature, volume, pH, and some variables of the model, are discussed with reference to atmospheric carbon-14 concentration available for plant growth. An expression is derived for the difference in age, Δt, that a sample would have if it were grown under a carbon-14 concentration different from that existing today. Since the "modern" carbon-14 specific concentration must be based on the equilibrium between the atmosphere, the biosphere and ocean reservoirs, changes in the reservoirs should affect the carbon-14 available for plant growth The ice age of about 18,000 years ago is known to have decreased the temperature and volume of water in the oceans. It must have also changed the amount of carbon dioxide available in the reservoirs. The model attempts to define an equilibrium condition of atmosphere-ocean at ocean temperatures from 5 to 0°C less than the present average world ocean temperature. Results are presented in terms of the difference in the expected age of samples grown at ocean temperatures less than the present temperature. The analytic model presented does not negate the effects of changes in cosmic flux, geomagnetism, sunspots, etc., on previous atmospheric carbon-14 concentration, but presents additional information on the possible distribution of carbon-14 based on changes in the equilibrium of the atmosphere, biosphere and hydrosphere. (auth)

6496 TRANSFER AND EXCHANGE OF ^{14}C BETWEEN THE ATMOSPHERE AND THE SURFACE WATER OF THE PACIFIC OCEAN. Bien, G.; Suess, H. (Univ. of California, San Diego, La Jolla). pp 105-15 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB–152 and CONF-670309.

Since 1958 the La Jolla Radiocarbon Laboratory has been carrying out determinations of carbon-14 in the bicarbonate of the surface and subsurface waters of the Pacific Ocean. In addition to the 85 determinations published previously, 55 new determinations have been carried out recently. The determinations show that, due to the uptake of bomb carbon-14, the carbon-14 content of surface water of the Pacific has been rising during the period of the observations. In the spring of 1966 it reached a level, in the northern latitudes of the Pacific Ocean, of approximately 20% above the normal. Going south, the increase becomes smaller and is negligible south of the Antarctic divergence. Also, the increase is smaller in costal areas than in the open ocean and it shows flat minima in the equatorial regions and around 45° northern latitude. The local variations can be explained by considering upwelling and increased rates of downward mixing. During the same period, the carbon-14 level in the atmosphere has increased to approximately 90% above normal. A comparison between the carbon-14 concentration in atmospheric carbon dioxide and ocean bicarbonate gives information on the rate of isotope exchange between atmosphere and ocean, a quantity most important in the evaluation of data for the fluctuations of the carbon dioxide level in the atmosphere. The knowledge of changes in the carbon-14 content of the inorganic bicarbonate of the surface water is also valuable in connection with carbon-14 age determinations of living and organic material in the surface waters of the ocean. (auth)

6497 TRANSFER OF RADIOCARBON IN NATURE. Nydal, R. (Norwegian Inst. of Tech., Trondheim). pp 119-29 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB–152 and CONF-670309.

In radiocarbon dating work, knowledge of the exchange rate of radiocarbon between various reservoirs in nature is of great interest. Artificial radiocarbon from nuclear tests performed in 1961 and 1962 has been used as a tracer in the present work. It was possible to investigate the rates of mixing between the various parts of the atmosphere before equilibrium was reached, in about four years. At the present time there is a good opportunity to make accurate measurements of the exchange rate between the atmosphere and the ocean. For this purpose, during the last year the amount of radiocarbon in the surface layer of the Atlantic Ocean has also been examined. (auth)

Mineralogy and Exploration

Refer also to abstract 6438.

6498 URANIUM AND THORIUM IN ANTARCTIC GLACIAL MARINE SEDIMENTS. Sugimura, Yukio (Meteorological Research Inst., Tokyo); Angino, Ernest E. Oceanogr. Mag., 18: 57-62(Dec. 1966).

The uranium and thorium content in Antarctic glacial marine sediments collected in the areas of the Ross, Bellingshausen and Amundsen Seas were determined. The average figure of uranium and thorium is 2.1 ppM and 8.3 ppM, respectively, with an average Th/U ratio of 4.6 was obtained. It was noted that an interesting geographical distribution of uranium and thorium was found in the area studied. (NSA of Japan)

6499 OPTIMUM SELECTIVE LOGGING CONDITIONS FOR VARIABLE-DENSITY ORES. Marenkov, O. S.; Pshenichnii, G. A. At. Energ. (USSR), 23: 245-6(1967). (In Russian).

During the selective γ-γ logging operations of manganese, iron and copper ores, an anomalous effect was noted when recording the integral intensity of the scattered γ radiation; this effect is due to variations in both the atomic number and the density of the ore. As no correlation has been established between the concentration of the metal and the density of the ore, it appeared desirable to establish conditions under which the density variations of the medium do not affect the reading. Monte Carlo calculations were carried out for this reason, attempting to correlate the integral intensity of the γ radiation, the distance x from the source to the detector and the density of the medium. Data from the Saksaganskii and Kivorozh fields were used for the elemental composition of the ores. The results indicated that the intensity–density correlation depends on the length of the probe used; for certain values of $x = d$ (d being the optimum length of the probe), the intensity is independent of the density. With increasing γ-quantum energy, d becomes larger. The sensitivity of the method is increased at low γ radiation intensities, because for ^{204}Tl the correlation is nonlinear at high iron concentrations. ^{170}Th was chosen as the γ emitter for selective logging. The theoretical predictions were experimentally confirmed. (TTT)

6500 X-RADIOGRAPHIC STUDY OF URANIUM MOLYBDATES. Dara, A. D.; Sidorenko, G. A. At. Energ. (USSR), 23: 126-33(Aug. 1967). (In Russian).

Experimental results of the investigation of the stability of natural uranium molybdates (umoboite, mourite, iriginite, Ca molyb-

date, and sedovite) to thermal processing are reported. The character of the phase transformation, undergone by these minerals during annealing at temperatures from 20 to 1000°C, was determined by x-ray methods. This made it possible to interpret the differential thermal curve of the molybdate. The character of the weight loss and the change of the color of the minerals, accompanying the phase transformation, were studied. The crystallization character of the water in all the investigated molybdates and the connection of the temperature of water loss with the degree of oxidation of the uranium in the minerals were established. The diagnostic x-ray and thermal characteristics of all the uranium molybdates studied are given. (tr-auth)

6501 ON TRACE ELEMENTS IN SOME SECONDARY URANIUM MINERALS OF SOUTHERN GERMANY. El-Hinnawi, Essam E. (National Research Centre, Cairo); Hofmann, Richard. Neues Jahrb. Mineral., Monatsh., No. 4/5, 143-51 (May 1967). (In German).

Findings are reported from x-ray diffraction studies of various U-containing minerals, including autunite, torbernite, zeunerite, uranophane, kasolite, and woelsendorfite obtained from 18 localities in southern Germany. Results of the measurements agreed closely with other published results. Trace elements found in association with these minerals were quantized, and their relations to U present in the minerals are discussed. The distributions of the secondary U minerals tended to have zonal characteristics, and the proportions of trace elements present varied considerably with the geographic sources of the U minerals. The trace elements in the various minerals exhibited some degree of paragenesis, and the occurrence ratios of trace elements, such as Ag, Ba, Cu, Pb, and Zn, were somewhat similar in specific minerals as well as between different minerals. (BBB)

6502 U. S. URANIUM RESERVES. A REPORT BY THE COMMITTEE ON MINING AND MILLING. New York, Atomic Industrial Forum, Inc., 1966. 9p. $7.50.

The present state of development of U. S. uranium reserves is discussed. The uranium industry recognizing the importance of adequate uranium supplies is determined to keep pace with the growth of nuclear power requirements. Sufficient uranium is available to permit electric power companies to proceed with plans for additional power reactors for a number of years. Results of current exploration should be apparent before 1971 and utility executives can then assess, on a continuing basis, the condition of the country's uranium reserves. (F.S.)

6503 PROCESS FOR THE CONCENTRATION OF URANIFEROUS ORES. Berri, Rino; Roques, Emile; Sialino, Ernest; Vial, Jean (to Commissariat a l'Energie Atomique). British Patent 1,094,203. Dec. 6, 1967. Priority date Jan. 22, 1965, France.

A process is described for concentrating uraniferous ores in the tetravalent state as oxides, silicates or organic uranium complexes which are in a highly divided state and locked in silico-aluminates or basic carbonate gangues such as Permian sandstone. The process consists of grinding the ore; adding metal sulfides, gypsum or sulfur, an alkali-earth metal chloride, and free silica so that the quantity of silica is double that of CO_2 present in the ore; and heating to 750 to 900 C. During the heat treatment, the silico-aluminates or basic gangues are converted to a silico-aluminous gangue from which uranium can be extracted by leaching with an acid solution which does not attack the transformed gangue. (F.S.)

Oceanography

Refer also to abstracts 6459, 6496, and 6497.

6504 PSEUDO-DIFFUSION IN OCEAN SEDIMENTS. Sarma, T. P.; Kohman, T. P. (Atomic Energy Establishment, Trombay, India). pp 308-19 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

Age estimation of ocean sediments is important in geological studies. Previous dating methods assumed a constant rate of deposition of all sediment components and that subsequent changes were due to radioactive decay. A more accurate assumption is believed to be the "psuedo-diffusion" theory which takes into account the effect of mixing of the sediments near the surface. A mathematical solution is given for calculating the effect of this mixing on the decay of radioisotopes in the sediment. (L.C.L.)

6505 TRANSFER OF BOMB ^{14}C AND TRITIUM FROM THE ATMOSPHERE TO THE OCEAN. INTERNAL MIXING OF THE OCEAN ON THE BASIS OF TRITIUM AND ^{14}C PROFILES. Muennich, K. O.; Roether, W. (Univ., Heidelberg). pp 93-104 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

On the 1965 Atlantic cruise of the German research vessel "Meteor," a sampling program was initiated including atmospheric CO_2 and surface water for ^{14}C analysis, and atmospheric water vapor and depth profiles for tritium analysis. On following shorter "Meteor" cruises in the Northern Atlantic this program was continued, and has recently been extended to ^{14}C profiles down to a depth of 1000 m. The results obtained for surface-water samples and depth profiles are presented. The surface-water samples of both ^{14}C and tritium show a maximum at mid-latitudes and a distinct drop at the equator. Excluding samples on or near the shelf leaves a rather smooth latitudinal distribution of surface concentrations. Depth profiles of tritium show that in higher latitudes the tritium has penetrated to a considerable depth, whereas near the equator the bulk is still contained in the mixed layer. Presuming the ^{14}C depth profiles to be similar to those of tritium, and comparing them to atmospheric concentrations of the last decade, yields the oceanic inventory of ^{14}C and an estimate of the CO_2 exchange velocity atmosphere ocean as a function of latitude. The data indicate a latitude-dependent exchange velocity of CO_2 in the range from 0.7 to 3.2 km/yr with an average of around 2.1 km/yr, which corresponds to an exchange time of 5.4 yr. Since the fast vertical mixing at high latitudes in connection with transport by ocean currents may also result in the north-south gradient of the ^{14}C inventory, the latitudinal dependence of the exchange velocity calculated from the measured data is considered to be an upper limit only. (auth)

6506 TRITIUM IN THE MIXED LAYER OF THE NORTH PACIFIC OCEAN. Dockins, K. O.; Bainbridge, A. E.; Houtermans, J. C.; Suess, H. E. (Univ. of California, San Diego, La Jolla). pp 129-41 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

Some 350 samples of surface water collected between late 1959 and mid-1966 have been analyzed for tritium in a continuing attempt to determine the age (viz., the average lifetime before transfer into any other resevoir) of the mixed layer of the North Pacific Ocean, and the relative magnitudes of the tritium input by precipitation, and input by molecular exchange and other mechanisms. After the steep rise in the tritium concentration in North Pacific surface water in 1963 from an average of about 8 tritium units (TU) to 13 TU the average level remained essentially constant, reaching a flat maximum in late 1964 or 1965. Since then the level has decreased much more slowly than has the tritium concentration in Northern Hemisphere precipitation. These decreases, which are at most of the order of 25% and a factor of three, respectively, enable one to make an estimate of time constants and volumes involved. Estimations of the tritium input rate derived from the tritium concentrations of oceanic and coastal rains, together with the observed tritium concentration in ocean surface water, can be used to calculate values for both the residence time and size of the mixed layer. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 6436 and 6522.

6507 (PNE-1400) BRONCO OIL SHALE STUDY. Project BRONCO. (Bureau of Mines, Laramie, Wyo. Petroleum Research Center). Oct. 13, 1967. 64p. Dep. CFSTI.

The feasibility of using deeply buried underground nuclear explosions to break oil shale deposits for in situ retorting was examined. A nuclear explosion experiment was recommended to be designed to test the concept. The nuclear concept involves firing a deeply buried, totally contained nuclear explosive to fracture the shale, which would then be retorted in place. A number of methods of retorting the broken oil shale, and associated fracture zones are described. A location in the Piceance Creek Basin in western Colorado has been investigated as a site for further studies and field investigation. It is recommended that safety and engineering field work are done to determine whether the location is suitable for a field test. Project Bronco, a proposed 50-kiloton nuclear explosion experiment is described. The detonation will fragment and fracture a deep, thick oil shale deposit which will subsequently be retorted in place. Bronco will provide information related to: the technical and economic feasibility of the basic concept, a predictive capability for the physical effects of nuclear explosions, and the distribution of radioactivity and its behavior during retorting. Although the Bronco experimental design is based on a potential site in the Piceance Creek Basin, a pre-shot investigation will determine whether the nominated site will meet the technical and safety criteria for a first nuclear explosion in oil shale. Following site confirmation, holes will be drilled for fracture studies, emplacing the explosive, and for shock wave measurements. The explosion is expected to produce a chimney 230 ft across and 520 ft high (measured up from the shot point), containing over one million tons of fragmented oil shale. Fractures may extend as far as 460 ft laterally beyond the chimney edge. Post-shot drilling will reveal the size and shape of the chimney, the extent of fracturing, and the distribution of heat and radioactivity. Final design of the in situ retorting experiment will depend on results of the post-shot exploration and on laboratory research currently under way. Tentatively, mixtures of air and recycle gas will be injected via drill holes to the chimney top. Drill holes to the chimney bottom will remove off-gas, oil mist, and liquid oil. During retorting, measurements will be made of temperatures in the chimney. Samples of gas and oil will be analyzed for physical characteristics, chemical composition, and radioactive content, if any. Additional data on retorting efficiency will be obtained in post-retorting drill holes. It is planned to follow the chimney retorting with an experimental outward moving treatment in a 45° sector of the fractured region outside the nuclear chimney. (auth)

6508 (PNE-5010) ENGINEERING PROPERTIES OF NUCLEAR CRATERS. A STUDY OF SELECTED ROCK EXCAVATIONS AS RELATED TO LARGE NUCLEAR CRATERS. Kley, Ronald J. (Army Engineer Nuclear Cratering Group, Livermore, Calif.); Lutton, Richard J. (Army Engineer Waterways Experiment Station, Vicksburg, Miss.). Sept. 8, 1967. 159p. Dep. CFSTI.

Analogies between nuclear and conventional excavations were developed from a tabulation of data from 153 mine, quarry, roadway, and dam excavations. The following factors were used as the basis for tabulation of conventional excavation data: purpose, location, precipitation, temperature, ground water level, lithology, mass strength, structural pattern, slope plan, slope profile, depth of excavation, slope height, average inclination, and stability. It was found that average slope inclination tends to be greatest for hard material and for material lacking a well-developed structure and that inclination tends to decrease with increasing slope height for excavated slopes reported to be stable. It is concluded that good analogies are to be found in shape, slope height, depth of excavation, and slope inclination. Loadings of waste material at the rim of some open pit mines may be analogous to ejecta on the lips of nuclear craters. Rubble zones found in some open pit mines may be analogous to the fallback zones of nuclear craters. Differences between preshot and postshot characteristics of cratered media must be appreciated in evaluating analogies between features of conventional excavations and preshot features of nuclear excavation sites. Brief descriptions of 21 selected excavations are presented in Appendix A. The results of this study serve as an aid to judgment of nuclear crater slope stability. Potential subjects for further study are identified. (auth)

Facilities and Equipment

Refer also to abstracts 6426, 6483, 7014, 7213, 7214, 7264, 7606, and 7961.

6509 (BMwF-FBK-67-14) DYNAMISCHE UNTERSUCHUNGEN AN AEROSTATISCHEN QUERLAGERN. (Dynamical Investigations on Externally Pressurized Gas Journal Bearings). Huber, P. R. (Technische Hochschule, Brunswick (West Germany). Institut fuer Maschinenelemente und Foerdertechnik). Feb. 1967. 134p. (In German). Dep.

Dynamic investigations of shafts, which are supported in two journal bearings (3 in. dia) with four variable-volume cavities for pressurized air are reported. The shaft mass must be small, the film stiffness must be large; the clearance ratio must be 1.2%. The unbalance must be statical; dynamical unbalances lead to conical shaft movements. The optimum depth of the cavity was 1.18×10^{-3} in. Theoretically the movements may be written by Hill's differential equations, which have several fields of instability. The subharmonic instabilities are critical. Perturbation methods are used to calculate two cases exactly. (tr-auth)

6510 (EUR-3605d) 2,4-MW DRUCK- UND SIEDEWASSER-KREISLAUF ZUR UNTERSUCHUNG DES WAERMEUEBERGANGS. (2,4-MW Pressure and Boiling-Water Loop for Heat Transfer Studies). Herkenrath, H.; Moerk-Moerkenstein, P. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). June 20, 1967. 35p. (In German). Dep.

One of the most significant directions of the development of light water reactors is the application of higher system pressure. This development led to an extensive experimental program for the investigation of heat transfer with water in the pressure range up to 230 bar. The experimental facilities of this program, with special regard to the water test loop which allows investigations of test sections of realistic dimensions with a maximum power input of 2.4 MW are described. (auth)

6511 (EUR-3618f) LE LABORATOIRE α, β, γ DE'INSTITUT EUROPEEN DES TRANSURANIENS: DESCRIPTION. (The α, β, γ Laboratory of the European Institute for Transuranium Elements: Description). Samsel, G. (European Atomic Energy Community, Karlsruhe (West Germany). Inst. of Transuranium Elements). May 3, 1967. 42p. (In French). Dep.

The $\alpha-\beta-\gamma$ laboratory of the European Institute for Transuranium Elements at Karlsruhe began its active work at the end of 1966. It includes thirteen working cells as well as a complete and independent decontamination plant. The high activity cells reserved for mechanical operations and physical examinations are equipped with movable alpha-boxes; these boxes can be handled by a remote-control crane. The medium-activity cells, in which radiochemical examinations are carried out, are equipped with a double cover device in order to effect their loading and unloading by means of a movable transfer caisson. (auth)

6512 (EUR-3619f) LE LABORATOIRE α, β, γ DE L'INSTITUT EUROPEEN DES TRANSURANIENS. EQUIPMENT UTILISE POUR LES EXAMENS POST-IRRADIATION SUR DES ELEMENTS COMBUSTIBLES AU PLUTONIUM. (The α, β, γ Laboratory of the European Institute for Transuranium Elements. Equipment Used for Post-Irradiation Examination of Plutonium Fuel Elements). Coquerelle, M. (European Atomic Energy Community, Karlsruhe (West Germany). Inst. of Transuranium Elements). 1967. 45p. (In French). Dep.

The experimental devices developed at the $\alpha-\beta-\gamma$ laboratory of the European Institute for Transuranium Elements, Karlsruhe, for remote-controlled physical measurements on irradiated plutonium fuels are described. Items of equipment include a metallographic and a microscopic installation, instruments for technological measurements, such as metrology, gamma-scanning, density, volumetric determination of the release for the fission gases, and a microsampling device. (auth)

6513 (LA-3786) PIPE CLOSURE BY EXPLOSIVES. Harper, J. D. (Los Alamos Scientific Lab., N. Mex.). Sept. 1966. Contract W-7405-eng-36. 9p. Dep. CFSTI.

High explosives were used to close aluminum, copper, and steel pipes in various sizes up to three feet in diameter. Closure times of less than one millisecond are typical. (auth)

6514 (NYO-841-10) HIGH CAPACITY-HIGH EFFICIENCY FILTERS FOR SODIUM AEROSOLS. Viles, F. J. Jr.; Himot, P.; First, M. W. (Harvard Univ., Boston, Mass. Harvard Air Cleaning Lab.). Aug. 1967. Subcontract CTZ-42050-1. 176p. Dep. CFSTI.

Various configurations of graded, deep bed filters were tested to evaluate their application for controlling fumes which might be released in an accidental loss of coolant from a sodium cooled reactor. Deep bed fiber media, when arranged in graded fiber diameters and graded packing densities and when followed by a pleated absolute filter are capable of collecting elemental Na and Na oxide fumes at 99.9% efficiency and storing large amounts of fume in excess of 0.5 lbs of Na per sq ft of filter face area with filtration velocities of 6 to 12 ft/min (NTP) and a terminal filter resistance of 20 in. of water gage. (F.S.)

6515 (SC-TM-67-827) CONTROL OF BERYLLIUM DURING IMPACT TESTS. Juskiewicz, A.; Skillern, C. P. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1967. 13p. Dep. CFSTI.

Beryllium was shattered in an air gun during an experiment. To control the beryllium particles that resulted, a special containment vessel with a highly efficient filtered exhaust was built. Utilizing this containment vessel, the release of beryllium particulates was minimized. A high efficiency filter was also placed on the room exhaust. It prevented releases of beryllium above AEC acceptable limits to the outside atmosphere. (auth)

6516 (SC-TM-67-862) HIGH INTENSITY CARBON ARC IMAGING FURNACE. Keltner, N. R. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1967. Contract AT(29-1)-789. 16p. Dep. CFSTI.

Small arc imaging furnaces used for testing small material samples at high heating rates is described. One furnace uses two 60-in. searchlight reflectors for the optical system and a large, high-intensity dc arc for the thermal source to test material samples up to $1\frac{1}{4}$ sq^2 and small component assemblies at high incident heat fluxes. The other furnace uses a commercially available projector and is used to test material samples up to $\frac{1}{2}$ in. in dia. (F.S.)

6517 (TID-24137) EARLY BLOWDOWN (WATER-HAMMER) ANALYSIS FOR LOSS-OF-FLUID TEST FACILITY. Fabic, Stanislav (Kaiser Engineers, Oakland, Calif.). June 1965. Revised Apr. 1967. Contract AT(10-1)-1165. 107p. Dep. CFSTI.

During the early part of the reactor coolant blowdown rarefraction (acoustic) waves propagate through the system in the same fashion as during the water-hammer in the liquid filled piping system, initiated by the sudden opening of a gate valve. However, since the loss of liquid causes the local pressures to drop below saturation, evaporation takes place at the exit and gradually spreads throughout the system. Water-hammer may persist in the part of the system that still contains liquid. The analysis applicable to the blowdown-induced water-hammer, where transition to the two-phase blowdown takes place is formulated. The well-known water-hammer equations for the liquid filled pipes are first deduced from the basic conservation laws. The wave superposition method is then described, applicable to the solutions, first of the liquid filled systems and, second, of the systems in which the phase change is occurring. The method described could be interfaced with Kaiser's two-phase blowdown analysis but this was not attempted. Instead, a digital computer program is described for the frictionless form of the wave superposition method which applies to blowdown only until the steam phase has started to form. Flow charts, Fortran listing, and a sample problem are included. (auth)

6518 COST OF HEAVY WATER PRODUCTION BY USING BITTERNS WATER. Kumar, R.; Datta, R. L. (Indian Inst. of Science, Bangalore, India). Indian Chem. Eng., 8: No. 1, 2-5 (1966).

Calculations were made for the percentage reduction in the cost of production of heavy water by using different concentrations of feed water over the cost of production, and using water of normal abundance. Since bitterns has an average D_2O concentration of 0.0257 mole % as against 0.0150 mole % in normal water, the use of bitterns water on the surface peels off continuously. Aluminum and its alloys show high resistance to corrosion. Among the 300 series of stainless steels, types 302 and 316 show max resistance to corrosion. (Indian Sci. Abstr.)

6519 IMPROVEMENTS IN OR RELATING TO STEAM POWER PLANTS. Wootton, William Robert (to Babcock and Wilcox Ltd.). British Patent 1,088,372. Oct. 25, 1967. Filed July 4, 1963.

A power plant is described which includes a prime mover arranged to receive steam from a boiler and to operate with steam bleeding between stages or a series of connecting units. The boiler has at least one stage in which steam is generated by direct contact of superheated steam with water. Methods are provided for condensing steam produced by the boiler and collecting the condensate as relatively pure or potable water. (F.S.)

6520 DEVICE FOR PACKING POWDER. Wakasugi, Kazuhiko (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-12476. July 14, 1966. Filed Jan. 31, 1963.

A device is described for densely packing nuclear fuel material into reactor fuel-rod tubes, or metallic or ceramic powder into thin tubular bodies. The tubular body to be packed is supported through a plate spring on the vibrator, which is also supported through a spring. The resonance required can thus be caused in the vibrating system, consisting of the vibrator and the tube itself. By means of this resonance, a large acceleration is given to the powder particles in the tube, providing a dense and uniform packing of powder in the tube. (NSA of Japan)

6521 IMPROVEMENTS IN OR RELATING TO THE SWAGING OF METALS AND APPARATUS THEREFOR. Lloyd, Henry; MacLean-Elrick, Alexander (to United Kingdom Atomic Energy Authority). British Patent 1,093,661. Dec. 6, 1967. Filed Mar. 9, 1965.

A method and equipment for swaging molybdenum and tungsten are described. The equipment consists of a plurality of balls, an outer race for the balls, a method for rotatably mounting and driving the outer race, and a heating method incorporated in the swage so that the workpiece is maintained at an elevated temperature while in the equipment. (F.S.)

6522 VEHICLE FOR COMBATING DAMAGE AND INJURY IN CONTAMINATED AREAS. (to Daimler-Benz Aktiengesellschaft). British Patent 1,093,510. Dec. 6, 1967. Priority date Nov. 17, 1965, Germany.

A vehicle is described which can be used for combating damage and injury in areas contaminated by atomic, bacterial or chemical substances. It consists of a driver's cab with built-in communication equipment and a method for measuring radioactivity outside the cab; a central superstructure having a control room with radiation measuring equipment and a separate room for decontaminating persons or objects; and a rear superstructure separate from the central superstructure equipped with at least one water tank, pumping equipment, and compartments for storing other items of equipment. (F.S.)

6523 GENERATION OF HIGH MAGNETIC FIELDS. Parkinson, D. H.; Mulhall, B. E. International Cryogenics Monograph Series. London, Heywood Books, 1967. 177p. 70s.

The theoretical aspects of magnetic fields are discussed, and a description is given of techniques that can be employed in the generation of these fields. Chapter headings are as follows: Introduction and general survey; solenoid analysis; cooling; solenoid construction and instrumentation; power supplies; hard superconductors; superconducting solenoids; pulse technique and flux concentration; future prospects. (UK)

6524 VAPOR GENERATOR. (to Combustion Engineering, Inc.). British Patent 1,089,027. Nov. 1, 1967. Priority date Dec. 30, 1964, United States.

A vapor generator of the shell and tube type is described. Heat is supplied by a heating fluid flowing in U-tubes which are arranged in separate tube bundles located in circumferentially spaced positions about a central downcomer forming an annular vapor generator chamber. The vapor generator is capable of extracting heat from high-temperature vaporized liquids and transforming it into vapor. (F.S.)

6525 TV-MONITORED METHOD AND MACHINE FOR TAKING A SAMPLE FROM THE WALL OF A CONDUIT. Charlade, Jean (to Commissariat a l'Energie Atomique). British Patent 1,093,990. Dec. 6, 1967. Priority date July 22, 1965, France.

A method and a machine are described which are used in taking samples at an appreciable distance from the walls of a conduit or passage of any cross-section and of any longitudinal section. Sampling is monitored by television. The equipment is especially useful in taking graphite samples from a nuclear reactor. The machine consists of a driving motor, television camera, a remotely operated cutting tool, and a container to hold the samples. (F.S.)

Heat Transfer and Fluid Flow

Refer also to abstracts 6510, 6519, 6524, 7821, 7833, 7861, and 7862.

6526 (AEEW-R-553) DRYOUT DURING FLOW AND POWER TRANSIENTS. Moxon, D.; Edwards, P. A. (Atomic Energy Establishment, Winfrith (England)). Oct. 1967. 42p. Dep. CFSTI. UK 7s.

Transient tests are reported and analysed, aimed at testing the validity of the methods currently used to predict the onset of dryout during flow and power transients in the SGHW Prototype Reactor.

The experiments were carried out with forced convection water at 1000 lb/in^2. absolute. Four different test sections were used: uniformly heated tubes of 6 ft and 12 ft, and uniformly and nonuniformly heated 37-rod clusters of 12 ft heated length. The flow transients were initiated by tripping the circulating pump and the power transient by the use of a switching circuit and a dummy load which gave a virtually instantaneous increase in power. By these means very fast transients were achieved, the flow being halved in under half a second, and the power to coolant in one test rising to 130% of its initial value in the 0.2 sec before the onset of dryout. For all tests in which the experimental and theoretical predictions differed significantly, the predicted time of dryout was earlier than the experimental time, but for the nonuniformly heated tube the discrepancy between these times was very small, being about 0.1 sec. (auth)

6527 (ITEF–455) RASCHET TEPLOVYDELENIYA V TSILINDRICHESKIKH BLOKAKH. (Calculation of Heat Release in Cylindrical Fuel Elements). Mikhailov, V. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1966. 47p. (In Russian). Dep.

The quantity of energy produced in the cylindrical fuel element with homogeneous distribution of fuel material as well as its radial dependence is calculated. It is shown that the distributions of radiation flux and fast neutron fission density can produce a deviation of the radial dependence of the total energy production from that one which is proportional to the thermal neutron flux. This deviation can be of such an extent that at some cases it should be taken into account in thermal engineering calculations. (auth)

6528 (WAPD–315(Vol.1)) BIBLIOGRAPHY ON HEAT TRANSFER AND FLUID MECHANICS ASPECTS OF NUCLEAR REACTORS. Burr, E. H.; Sternberg, V. A.; Belusar, F. J.; Green, S. J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Aug. 1967. Contract AT(11-1)-Gen-14. 393p. Dep. CFSTI.

A bibliography on heat transfer and fluid mechanics aspects of nuclear reactors is presented. Volume 1 contains 3390 references collected and evaluated over the ten-year period which ended December 31, 1966. The author index is also contained in Volume 1. Volume 2 contains the subject index prepared by the Key Word in Context (KWIC) System. (R.C.K.)

6529 (WAPD–315(Vol.2)) BIBLIOGRAPHY ON HEAT TRANSFER AND FLUID MECHANICS ASPECTS OF NUCLEAR REACTORS. Burr, E. H.; Sternberg, V. A.; Belusar, F. J.; Green, S. J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Aug. 1967. Contract AT(11-1)-Gen-14. 326p. DTIE.

A bibliography on heat transfer and fluid mechanics aspects of nuclear reactors is presented. Volume 2 contains the subject index for the 3390 references contained in the bibliography. The subject index was prepared by the Key Word in Context (KWIC) System. (R.C.K.)

6530 EXPERIMENTS ON THE FREE CONVECTION HEAT TRANSFER FROM A VERTICAL CIRCULAR CYLINDER. I. ON THE COEFFICIENTS OF THE HEAT TRANSFER TO WATER. Fujii, Tetsu; Takeuchi, Masanori (Kyushu Univ., Japan). Kyushu Daigaku Seisan Kagaku Kenkyusho Hokoku, No. 45, 17-28 (July 1967). (In Japanese).

Free convection heat transfer from a vertical circular cylinder of 82 mm diameter and 1000 mm height to water was studied experimentally for two cases of uniform surface temperature and uniform surface heat flux. The coefficients of heat transfer are calculated and arranged in nondimensional formula. In the laminar region these show good agreement with the numerical solutions of the boundary layer equations, and in the turbulent region there is found such an experimental formula as follows: $N_{ux} = 0.130\ (G_{rx}, P_r)^{1/3}$ where N_{ux}, G_{rx} and P_r are local Nusselt number, local Grashof number and Prandtl number respectively. It is found that the surface temperature can not be held constant when the boundary layer becomes turbulent. Especially in the process of the transition of the vortex street layer into the turbulent layer, the surface temperature fluctuates with larger amplitudes and with the same period with which the break up position of the vortex street shifts in the vertical direction. (NSA of Japan)

6531 STUDIES ON THE DETERMINATION OF ORE CONCENTRATION AND THE WATER CONTENT BY MEANS OF RADIOACTIVE ^{241}Am. Fushimi, Hiroshi (Waseda Univ., Japan). Nippon Kogyo Kaishi, 83: 568-70(Mar. 1967). (In Japanese).

The ore concentration, flowing through a 6" (15 mm ID) Polynite pipe, was measured by the transmittance method with a ^{241}Am radiation source, and the results were compared with those by the pressure difference method. The results agreed well with the latter, showing the high accuracy of the method. The same sample was taken in a cylinder of 10 × 10 × 15 cm and its sedimentation velocity was measured by changing the measuring height; it was found that the constant-rate sedimentation and the compression dehydration could be observed by selecting the suitable source heights. The measurement of the water content was simulated by mixing polyethylene or wheat starch in the sample. 32 to 40 kg of the sample was sufficient for the measurement. (NSA of Japan)

6532 EXPERIMENTAL DETERMINATION OF THE SLIP RATIO IN A VERTICAL BOILING CHANNEL UNDER ADIABATIC CONDITIONS AT ATMOSPHERIC PRESSURE. Cimorelli, L.; Evangelisti, R. (CNEN, Casacci, Italy). Riv. Ing. Nucl., 5: 1341-60(Mar.-June 1967). (In Italian).

The slip ratio was measured in a vertical boiling channel using a method based both on the direct determination of the velocity of the vapor phase and by measurement of the stationary value of the void fractions and then correlating this mean value to the mean velocity of the liquid phase. The theoretical equations describing the slip ratio are derived and evaluated, the processing of the experimental data is compared in some detail and the experimental results are compared with those predicted by theory and with previous experimental results. (J.S.R.)

6533 DESIGN OF REGENERATIVE HEAT EXCHANGERS. Datskovskii, V. M. (Odessa Technological Inst.). Teploenergetika, 9: 88-91(Sept. 1967). (In Russian).

In regenerative heat exchangers the heat transfer between a porous matrix and a gas is described by the following sets of equations: with heating of the matrix 1) $-\partial\theta/d\chi = \theta - T$ and $\partial T/\partial\tau = \theta - T$; and with cooling matrix 2) $-\partial\theta/\partial\chi = \theta - t$ and $\partial t/\partial\tau = \theta - t$. Here the θ's are gas temperatures, and T and t are matrix temperatures. An analytical solution of these equations is not available for practical use, but a simple approximate solution is developed. This method is significantly simpler than the well-known approximation methods of designing regenerative heat exchangers. (TTT)

6534 STUDIES OF HEAT TRANSFER AND CRITICAL THERMAL FLUXES DURING BOILING OF A MIXTURE OF BIPHENYL AND BENZENE. Sterman, L. S.; Abramov, A. I. (Moscow Power Engineering Inst.). Teploenergetika, 9: 59-63(Sept. 1967). (In Russian).

A mixture of biphenyl and benzene was heated electrically, and the change from nucleate boiling to film boiling was determined from the sharp change in electrical resistance of an experimental section where the change in type of boiling took place. With a 95% benzene mixture the critical heat flux did not depend on the type of material or surface. Further experiments were carried out with stainless steel plates 5 mm high, 1 mm thick and 100 mm long, which were mounted on the narrow edge. Subcooled liquids were boiled at pressures of 1, 7.9 and 17.7 bar with a change in subcooling from 0 to 100°C. The benzene concentration was varied over its entire range of concentrations. The critical heat flux showed two maxima at 50% and 80% benzene with a pressure of 7.9 bar, and only one maximum at about 70% benzene with a pressure of 17.7 bar. It was assumed that a concentration gradient existed in the boundary layer to explain these results. In mixtures of highboiling and lowboiling organic liquids the critical thermal flux signifying change in type of boiling increases, while the heat transfer coefficient decreases as compared to the single component liquids. (TTT)

6535 TEMPERATURE VARIATIONS ON THE SURFACE OF A STRIP-HEATED FLAT PLATE. Van Sant, J. H. (Univ. of California, Livermore). Contract W-7405-eng-48. J. Heat Transfer, 89: 372-3(Nov. 1967). (UCRL–14638).

An infinite flat plate heated by equally spaced strips on one side and cooled by convection on the other side is discussed. The variation of temperature on the cooled surface caused by adiabatic regions between the heat source strips is necessary to obtain a uniform temperature surface. Estimates of the maximum change of temperature along the cooled surface for the cases of constant temperature and constant heat flux strips are presented. (F.S.)

6536 TRANSIENT HEAT TRANSFER FOR TURBULENT FLOW OVER A FLAT PLATE OF APPRECIABLE THERMAL CAPACITY AND CONTAINING TIME-DEPENDENT HEAT SOURCE. Soliman, M. (AiResearch Mfg. Co., Los Angeles); Johnson, H. A. J. Heat Transfer, 89: 362-70(Nov. 1967).

An approximate analysis and experimental data are presented for the transient mean wall temperature of a flat plate of appreciable thermal capacity, heated by a step in the heat generation rate and cooled on both sides by a steady, incompressible turbulent flow with a Prandtl number of unity. Theory and experiments are in agreement over a range of Reynolds numbers $5 \times 10^5 \leq Re_L \leq 2 \times 10^6$. The experimental mean heat transfer coefficient is observed to go through a dip to a minimum before reaching the steady state. This dip is found to be due to the conjunction of a large wall thermal capacity and a sufficiently high flow velocity. (auth)

Isotope Technology

Refer also to abstracts 6449, 6480, 6672, 6674, 7874, 7878, and 7880.

6537 (MMM-3824-0002(Vol.1)) SNAP-23A PROGRAM POST-TEST ANALYSIS PLAN AND REPORT. VOLUME I. ANALYSIS PLAN. Field, D. R. (Minnesota Mining and Mfg. Co., St. Paul. Isotope Power Lab.). Nov. 1967. 49p. Dep. CFSTI.

The post-test analysis plan for the SNAP-23 six-couple Module A-2 and 252-couple prototype Converter P-1 is given. All converter components will be inspected and analyzed to determine any change in the thermoelectric materials. Converter P-1 was held at the design temperature throughout the entire test life. Converter P-2 was tested at considerably lower temperatures. Module A-2 experienced large voltage and resistance changes which should be more evident in Module A-2 than in Module A-3. The post-test examination will include quality control data, processing data, and physical, thermoelectric and chemical analysis of residual thermoelectric legs from the same lot and batch used in the converter and module. The inspection and analyses of the converter and module will be conducted on thermoelectric couples and adjacent components. After the pre-test, test, and post-test data are compiled, conclusions and supporting data will be reported. (F.S.)

6538 (MMM-3824-0002(Vol.2)) SNAP-23A PROGRAM POST-TEST ANALYSIS PLAN AND REPORT. VOLUME II. ANALYSIS REPORT. Field, D. R. (Minnesota Mining and Mfg. Co., St. Paul. Isotope Power Lab.). Nov. 1967. 121p. Dep. CFSTI.

The post-test analysis, observations, results, and conclusions drawn from the operation of the SNAP-2,3 six-couple Module A-2 and 252-couple prototype Converter P-1 are given. The post-test examination was conducted to establish potential failure or degrading mechanisms within the converter and module. Both the converter prototype and the module had anomalies in their thermoelectric performance during testing. Module A-2 had large fluctuations in output power due to a decrease in resistance across the P leg-hot electrode contact regions and due to a decrease in Seebeck voltage for the P legs and an increase in resistance across the N leg-hot electrode contact regions. Converter P-1 operated stably for 10,800 hrs. Higher spring pressure and lower hot electrode temperatures contributed to the stable performance. Misalignment of the legs within the converter did not affect converter performance. Thermal impedance between the cold caps and cold frame was caused by the inability of the heat transfer grease to maintain good thermal contact between the cold caps and followers. A Ni coating appears to restrict Cu migration into the cold segment material. (F.S.)

6539 SNAP 9A: SIGNIFICANT DEVELOPMENT FACTORS AND LAUNCH APPROVAL. Fink, Charles R. (Martin Co., Baltimore). Progr. Astronaut. Aeronaut., 16: 573-9(1966).

From 3rd Biennial Aerospace Power Systems Conference, Philadelphia, Sept. 1-4, 1964. See CONF-640901.

A brief summation of technical difficulties overcome in development of 9A and in obtaining safety approval of its launch is presented. Changes in couples, wiring, generator assembly and test prepping are defined. As regards launch approval, iterations in payload configuration to obtain a satisfactory burn-up design are described. The paper concludes that integration of isotopic power supplies with spacecraft should occur early in program definition rather than after the design of the spacecraft is frozen. (auth)

6540 LOW-POWER ISOTOPE THERMIONIC DEVELOPMENT PROGRAM (SNAP-13). Topper, Leonard (Atomic Energy Commission, Washington, D. C.). Contracts AT(30-1)-3060; AT(30-3)-217. Progr. Astronaut. Aeronaut., 16: 653-6(1966).

From 3rd Biennial Aerospace Power Systems Conference, Philadelphia, Sept. 1-4, 1964. See CONF-640901.

The program for development of a curium-242 fueled thermionic generator for use as an auxiliary space power source is described. (H.D.R.)

6541 NEW TECHNIQUE FOR ENRICHING TRITIUM BY THERMAL DIFFUSION. Ravoire, J.; Frejaville, G.; Montel, J.; Roth, E. (Centre d'Etudes Nucleaires, Saclay, France). pp 639-56 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2-10, 1967. See STI/PUB-152 and CONF-670309.

Tritium counting is generally preceded by enrichment, either by electrolysis of the water or by thermal diffusion over hydrogen. Electrolysis, a simple and certain method, is by far the more common, but the more delicate technique of thermal diffusion becomes interesting for concentrations lower than about 10 TU (1 TU = $T/H = 10^{-18}$). The enrichments are, in fact, more responsible, especially above a factor of 10, and the risks of contamination are lower. A program of isotope measurements in glaciology, performed in collaboration with the French Polar Expeditions, led to the application of this technique. The samples being in the form of water, the latter had always before been transformed into hydrogen by reduction over magnesium. To avoid this operation, an instrument was built which operates on the following principle: an auxiliary hydrogen current circulating in a closed loop is enriched in tritium from the water sample by the following exchange reaction: $HTO + H_2 \rightleftharpoons H_2O + HT$ which takes place in the vapor phase at high temperature, the water itself circulating in a co-current closed circuit; the enriched hydrogen then passes the depleted end of a thermal diffusion cascade, where it yields up part of the tritium it contains. The hot wire type columns are arranged in a two-stage cascade. After a sufficient time, almost all the tritium in the sample is transferred to the column which constitutes the second stage of the cascade, i.e., into a known volume of hydrogen. This hydrogen is counted under the form of ethane in an Oeschger counter. A series of measurements was performed in which two 80-cm^3 samples were treated per week, the first stage consisting of only one column. Since then the first stage has been increased to five columns, which means that three 250-cm^3 samples can be treated per week. (auth)

6542 USES OF RADIATIONS FOR INDUSTRIAL MEASUREMENTS. Otsuka, Iwao (Inst. of Physical and Chemical Research, Tokyo). Keisoku To Seigyo, 5: No. 8, 21-8(Aug. 1966). (In Japanese).

Radiation applications for industrial measurements in Japan are described. The results of questionnaires sent to 746 enterprises, industrial organizations, institutions and others are tabulated. A brief description is also given of papers, principles, constructions, etc., in connection with such devices and facilities. (NSA of Japan)

6543 RADIOISOTOPE ENERGY GENERATORS. Courouble, J. M. (CEA, Gif-sur-Yvette, France). Ann. Mines, No. 1, 25-30(Jan. 1967). (In French).

Energetic characteristics for 14 isotopes usable in isotopic generators are given. Possible modes for conversion of energy are explored; among these are thermoelectric conversion, thermionic conversion, several thermodynamic cycles, and direct conversion. For thermoelectric conversion all isotopes except γ emitters may be used. Polonium-210 was judged to be suitable because of the high power density and high temperature stability requirements. Thermodynamic converters should use a γ source such as ^{60}Co or ^{144}Ce. Direct converters of the radiovoltaic and radiophotovoltaic types may be based on β emitters, particularly ^{147}Pm and ^{3}H. Price and availability of radioisotopes are discussed. The experience of several European groups is cited. (UK)

6544 PROCEEDINGS OF THE ALL INDIA SYMPOSIUM ON RADIOACTIVITY AND METROLOGY OF RADIONUCLIDES, BOMBAY, MARCH 14-18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966. 534p. (CONF-660341).

Separate abstracts were prepared for the 45 papers presented. (W.H.K.)

For abstracts of individual papers see: 6438-6441, 6487-6489, 6504, 6545-6547, 6563-6574, 6618-6620, 6654, 6724-6729, 6811-6813, 6872-6875, 7617, 7706, 7707, 7745, and 7746.

6545 INTERNATIONAL INTERCOMPARISON OF ^{90}Sr-^{90}Y. Srivastava, P. K.; Khera, G. D. (Atomic Energy Establishment, Trombay, India). pp 21-34 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14-18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

Results are compared for the measurement of the specific activity of ^{90}Sr-^{90}Y in 24 laboratories of the world using samples of two radioactive solutions from the same bulk solutions with specific activities of about 1 μCi/gm and 12 μCi/gm respectively. Standardized measurement procedures were used to determine the activity of the solutions. (L.C.L.)

6546 EFFECT OF ISOTOPIC DILUTION FOR THE RADIONUCLIDES IN FISSION PRODUCT MIXTURES. Chakraborty, P. P.; Soman, S. D. (Atomic Energy Establishment, Trombay, India). pp 493-501 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14-18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

The build-up of radioactive and stable iodine in reactors as a

function of reactor operation time, both during operation and after shutdown, is described and the results presented graphically. (L.C.L.)

6547 STANDARDIZATION OF RADIONUCLIDES AT AEET. Gupta, U. C.; Srivastava, P. K.; Misra, S. C.; Sidhu, N. P. S.; Dhingra, K. C. (Atomic Energy Establishment, Trombay, India). pp 434-47 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966. See CONF-660341.

The present status of radioactive standardization at the Atomic Energy Establishment Trombay (India) is described. The different steps involved in standardization and considerations in the choice of the original radioactive solution together with a comparative study of the various counting methods are discussed. (auth)

Materials Testing

Refer also to abstract 6672.

6548 (LA-tr-67-94) APPARATUS FOR INVESTIGATING THE HARDNESS OF METALS AND ALLOYS OVER A WIDE RANGE OF TEMPERATURES. Borisenko, V. A.; Pisarenko, G. S. Translated by Helen J. Chick and James M. Dickenson (Los Alamos Scientific Lab., N. Mex.), from Porosh. Met., Akad. Nauk Ukr. SSR, 1: No. 5, 95-101(1961). 13p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

To study the temperature dependencies of the hardness of metals and alloys over a temperature range from 20 to 3000°C, a special apparatus for high-temperature hardness was designed and constructed. With this apparatus it is possible to measure the hardness in a high-purity inert gas atmosphere by two methods: static indentation by an indentor of a standard tetrahedral pyramid with an angle of 136° between opposite faces and unilateral flattening of conical samples. (M.C.G.)

6549 IMPROVEMENTS IN OR RELATING TO METHODS OF INSPECTING WIRE. Sayers, John Francis (to United Kingdom Atomic Energy Authority). British Patent 1,093,202. Nov. 29, 1967. Filed Jan. 14, 1966.

An improved method for inspecting drawn wire for metallic projections is described. Wire is passed axially through a hollow metal cylinder while a potential difference is maintained between the wire and the cylinder. This difference should be insufficient for a corona discharge to occur, but sufficient for a corona discharge in the presence of a projection. A method is described for controlling the corona discharge. (F.S.)

Protective Structures

Refer also to abstract 7340.

6550 (NP-17183) NUMERICAL ANALYSIS OF PLANE STRUCTURE-MEDIUM INTERACTION IN ELASTIC-PERFECTLY PLASTIC MEDIA. Civil Engineering Studies Structural Research Series No. 307. Chang, G. C.; Ang, A. H.-S. (Illinois Univ., Urbana). June 1966. 167p.

Numerical procedures were developed for determining the states of stress and strain in the neighborhood of a lined tunnel or tunnel-like cylindrical cavity embedded in an elastic or elastic-perfectly plastic half-space while engulfed by a blast wave traveling in a direction perpendicular to the axis of the tunnel. Data were obtained on the transmission of blast waves through the soil cover. In addition to variations in material properties, the effects of depth of burial, partial loading on the surface of the half space, and the shape of the cavity can be studied with a computer program written in FORTRAN for an IBM-7094. The data obtained are useful in the design of underground protective structures. (F.S.)

6551 RADIATION LEAK TESTS ON THE JOINTS OF A STRUCTURE. Tamai, Teruo; Ando, Ejyo (Ishikawajima-Harima Heavy Ind. Co., Ltd., Japan). Genshiryoku Kogyo, 13: No. 2, 38-41(Feb. 1967). (In Japanese).

Experimental investigations were made on radiation leaks through the joints of a structure, and also on methods of leak detection. The experiments were performed with a gamma-ray point source of ^{60}Co with gamma-ray energy 1.25 MeV on non-step, one-step, and two-step joints of lead and lead with iron lining. The radiation, leaking at the point of a joint, is mostly the penetrating component with a slight streaming. In the scale of joints studied, there is no need to consider rigorously the problem of streaming. Values of radiation leaks and their spatial distribution agree relatively well with those calculated by the ray analysis technique. However, in order to reach general conclusions on radiation leaks from joints, it is necessary to make systematic experiments and theoretical analyses by varying the shape of the radiation source, the energy, the shielding material and the radiation itself. (NSA of Japan)

Radioactive Material Handling

Refer also to abstracts 6511 and 6512.

6552 DECONTAMINATION OF PRODUCTS FROM CHEMONUCLEAR REACTIONS. Zipprich, Charles Frederick. Troy, N. Y., Rensselaer Polytechnic Inst., 1966. 139p. Thesis.

Investigations have been carried out to determine the extent of contamination and methods of decontamination of products from chemonuclear reactions. Enriched uranium incorporated in the structure of thin fibers provided the source of fission fragments and the means for their escape into the irradiated phase. The work was divided into three phases: determination of the % of the fission fragments that escape the glass fibers and investigation of several specific isotopes to elucidate their behavior relative to the bulk activity; examination of several methods for decontamination of carbon suboxide polymer. Alternate precipitation-dissolution cycles and ion exchange techniques were attempted; and decontamination of nitrogen dioxide by evaporation. Evaporation of NO_2 from nonvolatile ^{137}Cs gave decontamination factors of 10^7 to 10^8 at boil-up-rates of 300 to 400 lbs/hr-ft^2. It had been indicated that one could only expect values of 10^4 for the evaporator alone at such rates whereas 5×10^6 was obtained in this work. Additional experiments with mixtures of fission products indicated I, Xe, and possibly Tc were volatile under the conditions used. Decay measurements on condensate samples showed at least two nuclides in addition to I and Xe were present while aluminum absorption and gamma spectrometric analysis showed we were dealing with a weak beta emitter that gave off only a small amount of gamma rays at 0.070, 0.095, and 0.335 MeV. Identification was not possible because of the small amount of activity present. (Disser. Abstr.)

6553 DEVICE FOR DISCHARGING A RADIOACTIVE WASTE GAS. Yamaguchi, Masami (to Tokyo Shibura Elec. Co., Ltd.). Japanese Patent 1966-20760. Dec. 3, 1966. Filed Oct. 25, 1963.

A device is described for disposal of radioactive waste gas after several stages of dilution. The gas is discharged in small amounts, with the discharge rate adjustable, which leads to a reduction in the necessary capacity of discharge blowers and therefore to improved economy. It consists of a device for absorbing the waste gas in a carbon tetrachloride solution; a device for heat-condensing the resulting solution to release the radioactive gas; a device for again absorbing the released gas in a carbon tetrachloride solution; a waste discharge device, in which a small amount of the waste-gas contained solution is taken in and heated to condense it and release the radioactive gas, and finally the released gas is discharged to the atmosphere after dilution with air to below the permitted concentration. A device for returning the carbon tetrachloride to the system from the discharge device is also provided. (NSA of Japan)

INSTRUMENTATION

Radiation Detection Instruments

6554 WORK OF THE UNION SCIENTIFIC RESEARCH INSTITUTE OF INSTRUMENT CONSTRUCTION. Shekhovtsov, N. A.; Matveev, V. V.; Dneprovskii, I. S. At. Energ. (USSR), 23: 446-50(Nov. 1967). (In Russian).

The research activities of the Scientific Research Inst. for Nuclear Instrumentation are described. Data are presented on the various types of radiometric, dosimetric and spectrometric devices developed by the Institute. (R.V.J.)

General Detectors and Monitors

Refer also to abstracts 6354, 6441, 6445, 6544, 6796, 6848, and 7983.

6555 (BNWL-540) AUTOMATIC CONVEYOR TYPE LAUNDRY ALPHA-BETA-GAMMA CONTAMINATION MONITOR. Sheen, E. M.; Crouch, G. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1967. Contract AT-(45-1)-1830. 25p. Dep. CFSTI.

An automatic radiation monitoring system was developed by the Pacific Northwest Laboratory for the Federal Support Services of International Telephone and Telegraph to scan laundered protective clothing and automatically reject contaminated garments. This system employs two stainless steel wire belt conveyors that transport the wearing apparel at a belt speed of 160 in./min between two large alpha-beta-gamma scintillation detectors that simultaneously monitor upper and lower surfaces of each item of apparel for alpha-beta-gamma contamination. The instrument reliably sorts items for further decontamination if they are contaminated to a level greater than the equivalent of 25,000 dis/min (11 nCi) of Ra DEF or 1000 dis/min (0.45 nCi) of 5 MeV alpha emitters distributed over 100 cm^2. (auth)

6556 (CONF-650460-1) UTILISATION DES BANCS D'ESSAIS POUR LA VERIFICATION DES PERFORMANCES DU MATERIEL DE RADIOPROTECTION. (Utilization of Portable Testing Devices for Monitoring Radioprotective Materials). Jeanne, Georges (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [nd]. 9p. Dep.

From Technical Conference on Implements for Protection from Radiation, Grenoble, France.

Four portable devices were constructed for the rapid testing of radiation monitoring devices. These testing devices were designed to test each electronic tube, verify the principal voltages, etc. and to verify the principal characteristics of photomultiplier tubes. The purpose of each device is briefly outlined, and the results of a year's use are reported. The results indicate that a single annual obligatory visit is sufficient to maintain the monitors in good operating condition. (J.S.R.)

6557 (CONF-660663) SEMICONDUCTOR MATERIALS FOR GAMMA RAY DETECTORS. Report of the Meeting Held in New York City, June 24, 1966. Brown, W. L. (ed.) (Bell Telephone Labs., Murray Hill, N. J.); Wagner, S. (ed.) (Brookhaven National Lab., Upton, N. Y.). 94p. Dep. CFSTI.

Separate abstracts were prepared for the three papers presented. (W.H.K.)

For abstracts of individual papers see: 6558-6560.

6558 (CONF-660663-, pp 3-26) PHYSICS AND OPERATION OF SEMICONDUCTOR PARTICLE DETECTORS WITH PARTICULAR REFERENCE TO GAMMA DETECTORS. Miller, G. L. (Bell Telephone Labs., Murray Hill, N. J.).

The mechanism of gamma detection by semiconductor detectors is discussed, and the advantages of semiconductors for gamma detection are presented. Also, the parameters necessary for a semiconductor gamma-ray spectrometer are reviewed. (W.H.K.)

6559 (CONF-660663-, pp 27-36) PROSPECTS FOR HIGH PURITY GERMANIUM. Hall, R. N. (General Electric Co., Schenectady, N. Y. Research Lab.).

Considerations and conclusions concerning the purification of germanium for fabricating a thick p-i-n junction radiation detector are presented. Some of the problems encountered are described including lattice vacancies, dislocations, crucible and atmospheric contamination, and highly soluble impurities such as copper and gold. (W.H.K.)

6560 (CONF-660663-, pp 37-52) EVALUATION OF CdTe BY NUCLEAR PARTICLE MEASUREMENTS. Mayer, J. W. (Hughes Research Labs., Malibu, Calif.).

The properties of CdTe have been evaluated by investigating the pulse height response of surface-barrier devices to monoenergetic alpha particles incident normal to the surface. The energy ϵ required to form a hole-electron pair was found to be 4.65 ± 0.2 eV. The count rate efficiency and energy resolution that have been obtained indicate that crystals can be grown without major fluctuations in the densities of trapping or recombination centers. Values of the effective lifetime, (free time before trapping) within the high field regions range from less than 10^{-9} sec to 4×10^{-8} sec for holes and electrons. (auth)

6561 (ISS-67/17) UN COMPLESSO DI CONTATORI A SCINTILLAZIONE PER LO STUDIO DELLA DISTRIBUTIONE ANGOLARE DEI PROTONI NELLA REAZIONE (e,e'p). RAPPORTO TECNICO. (A Scintillation Counters Apparatus for the Study of the Angular Distributions of Protons in the (e,e'p) Experiment. A Technical Report). Campos Venuti, G. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). June 30, 1967. 28p. (In Italian). Dep.

The choice of the annular scintillation counters system to study the angular distributions of the protons in the (e,e'p) experiment is justified. Preliminary testing and adjustment are discussed. (auth)

6562 (NYO-2028-2, pp 150-8) LABORATORY FABRICATION OF LITHIUM-DRIFTED GERMANIUM DETECTORS FOR GAMMA RAYS. Wagner, Ronald S.; Tyler III, Mark V.; Lee, Yung-keun (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics).

Production of Ge (Li) detectors which meet the individual requirements of several projects in our laboratory was continued. In particular, the thin-window Ge (Li) detectors for soft gamma-rays were developed for Mössbauer experiments. Progress has been made in fabricating large area thin-window detectors and cooled-FET preamplifiers. (auth)

6563 TRACKS OF CHARGED PARTICLES IN SOLIDS AND THEIR APPLICATIONS IN METROLOGY OF RADIONUCLIDES. Price, P. B. (General Electric Research Lab., Schenectady, N. Y.). pp 1-14 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14-18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341

The production of tracks in materials when bombarded with massive energetic charged particles is discussed. Correlation of the track characteristics of materials is made with the electric conductivity of the materials. Age calculations of natural materials from studies of the tracks is also discussed. (W.H.K.)

6564 A HIGH PRESSURE 4π PROPORTIONAL COUNTER FOR MEASUREMENT OF ORBITAL ELECTRON CAPTURE RATE OF RADIONUCLIDES. Sahoo, H. K. (Atomic Energy Establishment, Trombay, India). pp 51-8 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14-18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

The design and use of a 4π proportional counter operated at elevated pressures for the standardization of orbital electron capturing radionuclides by measuring their K-x-ray emission rate is presented. The isotope ^{51}Cr, in the form of Na_2CrO_4, was standardized, and the procedure is described. (W.H.K.)

6565 STATUS OF EXPOSURE DOSE STANDARDIZATION. Rao, P. S.; Gupta, U. C. (Atomic Energy Establishment, Trombay, India). pp 72-7 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14-18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

The design of an interim standard for gamma exposure dose using a cobalt-60 source is presented. A graphite ionization chamber is used. (W.H.K.)

6566 LINEAR SCANNING. Ramanathan, P.; Ganatra, R. D.; Sharma, S. M.; Mehta, M. N. (Atomic Energy Establishment, Trombay, India). pp 133-41 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14-18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

The design and use of a radioisotope organ scanning apparatus are described. A multiprobe scanning unit was modified with a

special slit collimator used with a NaI crystal scintillation detector for the purpose of linear scanning. Techniques and capabilities of this modified linear scanning apparatus are presented. (W.H.K.)

6567 SIMPLE ANIMAL WHOLE BODY COUNTERS FOR METABOLIC STUDIES. Nagaratnam, A. (Inst. of Nuclear Medicine and Allied Sciences, Delhi). pp 142-53 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

A whole-body scintillation detection system for metabolic studies of laboratory animals is described. A single thallium-activated sodium iodide scintillation crystal is coupled to a single-channel gamma spectrometer and scaler. Shielding design to minimize background counts is described. (W.H.K.)

6568 LIQUID SCINTILLATION COUNTING FOR THE MEASUREMENT OF THE ACTIVITY OF ALPHA AND BETA EMITTERS. Bhatia, S. L.; Langroo, M. K. (Atomic Energy Establishment, Trombay, India). pp 167-79 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

The design of an organic liquid scintillation counting system for the study of the beta spectra of low-energy emitters and for low-level radioactivity measurements is discussed. Advantages of this system and several experiments using this system are also discussed. (W.H.K.)

6569 A METHOD FOR MEASUREMENT OF ^{41}Ar IN AIR USING A G–M COUNTER. Sachdev, R. N.; Sharma, L. N.; Shirvaikar, V. V. (Atomic Energy Establishment, Trombay, India). pp 180-6 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

The method of differential beta counting used in Trombay for field measurement of argon-41 is presented. A Geiger–Mueller detector is used, and the calibration technique is described. (W.H.K.)

6570 FAST NEUTRON MONITOR. Veer Raj Urs, A. S. (Atomic Energy Establishment, Trombay, India). pp 187-93 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

The design of a proton-recoil proportional counter which is based on the maximum permissible flux and used as a fast neutron detector is described. The sensitivity varies with neutron energy in the range 0.1 to 15 MeV so that the count rate is proportional to the dose rate. (W.H.K.)

6571 ABSOLUTE CALIBRATION OF THE CANADIAN NEUTRON STANDARD BY BF_3 CHAMBER TECHNIQUE. Sharma, D.; Shahani, M. G. (Atomic Energy Establishment, Trombay, India). pp 194-205 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

A description of the absolute calibration of the Canadian neutron standard using the boron trifluoride ionization chamber technique is presented. The correction factors necessary for the calibration are discussed. (W.H.K.)

6572 A CLOSED CIRCUIT TECHNIQUE FOR RADON MEASUREMENT IN WATER AND SOIL, WITH SOME OF ITS APPLICATIONS. Ghosh, P. C.; Bhalla, N. S. (AMD Lab., New Delhi). pp 226-39 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

A closed circuit technique for measuring the radon concentration in water and soil which is based on the alpha activity of radon and its daughter products is described. A ZnS(Ag) detector is used. Some experiments and particular uses for this apparatus are presented. (W.H.K.)

6573 SELF-RECORDING CAMERA FOR AIRBORNE RADIOACTIVITY SURVEY. Bhalla, N. S.; Bhatnagar, A. S. (AMD Lab., New Delhi). pp 240-9 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

The design of an apparatus for airborne radioactivity surveys which records the radioactivity level directly on the terrain photographs is presented. The advantages of this apparatus over conventional equipment and other details are discussed. (W.H.K.)

6574 APPLICATION OF GAS-PHASE COUNTING TECHNIQUE FOR DETECTION OF TRITIUM AND RADIOCARBON FOR HEALTH PHYSICS ASSAY. Soman, S. D.; Sadarangani, S. H.; Iyengar, T. S.; Yuthamanop, A. (Atomic Energy Establishment, Trombay, India). pp 320-34 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

A method for measuring the activities of carbon-14 and tritium is presented. The method consists of converting the sample into a suitable counting gas and recording the disintegrations with a Geiger–Mueller or proportional counter. (W.H.K.)

6575 SURVEY OF SYSTEMS FOR CONCENTRATION AND LOW BACKGROUND COUNTING OF TRITIUM IN WATER. Cameron, J. F. (International Atomic Energy Agency, Vienna). pp 543-73 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

Systems used for concentrating and counting tritium activities in the range 0.1–5,000 TU are surveyed. It should serve as a guide to the factors involved in such measurements, for scientists interested in practical applications of natural and bomb-produced tritium as a tracer, and for those who wish to construct similar apparatus. In most tritium-counting systems the criterion to be applied in comparing methods is the time required to achieve the desired rms relative precision. This time decreases with increasing sample activity, increasing amount of sample in the counter and with decreasing background. Counting systems compared are gas counters and the filling gases, scintillation counters and scintillators. The best proportional counters are considerably better than the best scintillation counters, but benzene synthesis and assay by liquid scintillation counting is as good as the best Geiger counters. To concentrate a single sample by a factor of 10, thermal diffusion is quicker and gives a more accurate enrichment factor. However, as thermal diffusion columns are bulky, it is easier with electrolysis to run simultaneously a larger number of samples, and the reproducibility is adequate for most purposes. The absolute accuracy of measurements at different laboratories is compared and it is shown that the standard deviation is generally better than about ±2%. (auth)

6576 EXPERIENCE GATHERED IN THE CONSTRUCTION OF LOW-LEVEL COUNTERS. Geyh, M. A. (Niedersachsisches Landesamt fuer Bodenforschung, Hanover). pp 575-91 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

Three different types of counters have proved successful in the low-level technique, namely, the quartz-tube counter, the Oeschger-type counter, and the plastic-scintillation counter. In constructing these types of counter diverse difficulties arise if high factors of merit and excellent plateau properties are desired. Detailed information on this subject is presented and both the advantages and disadvantages of the individual constructions are compared. Investigations were carried out on the suitability of several cathode materials to provide low background for quartz-tube counters. In the construction of the second and third type of counter the main problem is the selection of suitable plastic materials and their processing and treatment under special manufacturing instructions. By using unsuitable materials, and carelessness in the processing, irregular variations in the background or the sensibility of the counters to soft beta rays by de-gassing of the plastic materials occurred. Information was also collected on the suitability of anode wires and aluminized plastic foils for the construction of low-level counters. In particular, the properties of a 40 cm^3 plastic scintillation counter are described. In connection with the mixing of samples with old material, a formula was derived that allows prediction of the dating accuracy of a counter, which may be constructed, in comparison with existing counters. (auth)

6577 NEW ATTEMPTS IN LOW-LEVEL COUNTING AND A SEARCH FOR COSMIC-RAY-PRODUCED ^{39}Ar. Loosli, H. H.;

Oeschger, H.; Wahlen, M. (Univ. of Bern). pp 593-601 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

Two low-level counting systems developed for special problems, requiring minimum background, are described. For the measurements of low-activity tritium samples of high pressure a proportional counter with wire electrodes in a matrix array was built. It allows avoidance of losses of the sensitive volume due to end effects and electronegative impurities. The signals of each of the electrode wires can be collected separately. The anodes are combined into four groups, so that each wire is surrounded only by wires belonging to the other groups. Because of the short range of the electrons from the tritium decay only one wire group should show a signal. For the detection of ^{39}Ar in atmospheric argon and other isotopes of low specific activity and high β energy, a 1-liter proportional counter of Plexiglas coated with Al and Au was constructed. It is surrounded by a cylindrical guard counter of the same material. The shield consists of specially selected radioactively pure lead. On the top and on the sides big, flat multiwire guard counters are operated in anticoincidence. Pulse height analysis helps to identify the ^{39}Ar radiation and to reduce the background. The background reductions by different shield and anticoincidence counter arrangements are determined. It is shown that the estimated ^{39}Ar activity of 0.05 dpm/l atmospheric Ar can be measured with an accuracy of about 10%. (auth)

6578 STUDY OF THE BACKGROUND OF A LOW-LEVEL COUNTING DEVICE. Delibrias, G. (Centre d'Etudes Nucleaires, Saclay, France); Rapaire, J. L. pp 603-12 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

The residual background of a carbon-14 dating device was studied under different shieldings with a view to analyzing its various components. Measurements were made successively with a steel-bodied counter and a copper-bodied counter in the laboratory under shieldings of 320 and 510 g/cm^2 and in a cave under 15,000 g/cm^2 (about 60 m of calcareous rock). The improvement in the background obtained with the device in the cave made it possible to deduce the component of the residual background due to cosmic radiation, since a shielding of 15,000 g/cm^2 suppresses the whole of the nucleonic component of the cosmic radiation and 98.7% of the muons. With this degree of shielding the background of the copper counter was improved by 0.71 cpm by comparison with the laboratory (510 g/cm^2), while the background of the steel counter was improved by only 0.35 cpm. Various considerations lead us to think that this difference is due to nuclear reactions produced by the nucleonic component of the cosmic radiation on the counter walls. The difference cannot be attributed to the muons since, firstly, the contribution in question is the same for the two counters and, secondly, the barometric effect observed on the copper counter under 510 g/cm^2 (larger than that observed with the steel counter) would, if attributed to the muons, lead to a background contribution from this component incompatible with values measured elsewhere. In the case of the copper counter, whose background is 1.62 cpm under 510 g/cm^2, the proportion of this background due to the whole nucleonic component is estimated at 0.61 cpm and the muon component also at 0.10 cpm (efficiency of discriminating ring ≥99%). Under the same conditions, the nucleonic component in the case of the steel counter is estimated at less than 0.25 cpm. (auth)

6579 SENSITIVE AND DESCRIPT β AND $\beta-\gamma$ COUNTING ASSEMBLIES. Lal, D.; Rajagopalan, G.; Rama (Tata Inst. of Fundamental Research, Bombay). pp 615-27 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, France, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

Recent advances that were made towards high-sensitivity and descript measurement of trace quantities of radioactivity due to β and $\beta-\gamma$ emitters in solid sources of relatively high specific activity are described. The β-detection assembly provides accurate information on the characteristic energy of the radiation permitting its identification at low levels. The detection system is relatively inexpensive and simple, as Geiger counters are used as detectors. The information on the energy of the β radiation is obtained while measuring the total disintegration rate; thus the system has the versatility of detectors capable of providing information on the energy of individual β particles, e.g., solid state detectors and scintillators. The observed counting efficiencies and background rates of a few β and $\beta-\gamma$ systems constructed are discussed. The figure of merit of these detectors can be considerably enhanced by certain modifications which are in progress. The techniques discussed above have been developed to meet specific requirements encountered in the study of certain problems in nuclear physics and geocosmophysics. The $\beta-\gamma$ system was employed to measure the half-life of ^{48}Ca for single β decay: the measurements to date yielded a lower limit of 10^{19} yr for its half-life. (auth)

6580 COMPARISON OF TRITON-X EMULSION SYSTEMS WITH DIOXANE SOLUTIONS IN LIQUID SCINTILLATION COUNTING OF LOW-LEVEL TRITIUM IN WATER. Williams, P. H.; Florkowski, T. (International Atomic Energy Agency, Vienna). pp 703-9 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

The recent development of a technique involving the use of a Triton-toluene mixture as solvent for aqueous low-level tritium scintillation counting has prompted a comparison of this system with that based on dioxane-naphthalene as solvent. Optimum results of measurements made with a commercial Packard liquid scintillation spectrometer are as follows: for the dioxane system, a 25-ml sample containing 20% (i.e. 5 ml) water has a background of 8.4 cpm and efficiency of 12.1%, corresponding to 230 TU/cpm, and for the Triton system, a 25-ml sample containing 24% (i.e. 6 ml) water has a background of 10.0 cpm and efficiency of 16.8%, corresponding to 138 TU/cpm. Reproducibility of the Triton-toluene system (in which part of the water is solubilized and part emulsified by the Triton) is excellent and only a very little extra care is required for sample preparation. A comparison of actual counting times needed to give specified statistical precisions for samples in the range 500–10,000 TU shows that very considerable reduction is possible with the Triton system. The advantages of this system are also clearly demonstrated from a comparison of commonly used figures of merit. (auth)

6581 LOW-BACKGROUND COUNTING WITH SILICON DETECTORS. Chwaszczewska, J. (Central Inst. for Nuclear Research, Swierk, Poland); Przyborski, W.; Roman, J.; Slapa, M. pp 711-20 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

Large-area silicon detectors with a sensitive area of up to 4.5 cm^2 have been prepared. Their use in total activity measurements on low levels of activity was investigated. The stability, accuracy and reproducibility of counting rates in long-term operation are given. Measurement of the pulse-height distribution and intensity of cosmic-ray background are presented for various detector thicknesses. The large-area single-unit detectors are suitable for beta-ray spectra analysis in the low-energy range down to 10 keV. The background count of a beta-ray spectrometer consisting of two shallow silicon detectors operating in anticoincidence was less than 0.26 cpm per cm^2. (auth)

6582 4π LOW-LEVEL BETA COUNTER USING TWO Si–Au DETECTORS. Johnsen, S. J. (H. C. Oersted Inst., Copenhagen). pp 721-26 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, France, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

In connection with ^{32}Si dating, a 4π counter using two Si–Au detectors was constructed for counting β radiation from ^{32}P. The Si–Au counters were operated in parallel; the active area was 2 cm^2 for each counter. In the 100 keV–400 keV interval the background was as low as 2 cph, and the efficiency for 50 mg KCl was 50%. (auth)

6583 NANOSECOND PULSE SHAPER OF THE SCINTILLATION TRANSDUCER. Batalin, S. S.; Lysikov, Yu. A.; Shubnyi, Yu. K. (Inst. of Nuclear Physics, Alma-Ata, USSR). Prib. Tekh. Eksp., No. 4, 203-4(July-Aug. 1967). (In Russian).

The shaping device on the 6ZH22P tube with control of the cathode grid for fast-slow coincidence circuits with time-amplitude conversion and used with the scintillation transducer (FEU-36, crystal NaI(Tl)) was described. Stilbene, toluene, NaI(Tl), and plastic scintillators were used. The permissible time $2\tau_0$ was 0.4 nsec in self-coincidences and 1.2 nsec in coincidences with ^{60}Co sources. (tr-auth)

6584 COINCIDENCE AND ANTICOINCIDENCE CIRCUITS WITH MAXIMUM SWITCHING SPEED OF 40 MHz. Bushnin, Yu. B.; Dunaitsev, A. F.; Sen'ko, V. A. Prib. Tekh. Eksp., No. 4, 74-8(July-Aug. 1967). (In Russian).

A three-input coincidence circuit with a one-input anticoincidence circuit to be used in particle accelerator testing and recording of scintillation and Cherenkov counter output pulses is described. Circuits are direct-coupled arrangements of tunnel diodes, silicon diodes, and high speed germanium transistors which assure minimum dead time when negative polarity pulses are applied to their inputs. Sensitivity of circuits is better than 1 V when input pulses have a rise time shorter than 6 nsec. Coincidence and anticoincidence resolution times are 4 ± 1 nsec and 5 ± 1.5 nsec, respectively. Due to direct coupling of circuit elements, circuit sensitivity and dead time is independent of load and output pulse amplitudes. The maximum switching frequency of the circuit is 40 MHz. (ATD)

6585 RANGE OF IONS OF LIGHT ELEMENTS IN THE PHOTOEMULSION NIKFI-YA2. Dmitriev, I. S.; Teplova, Ya. A. (Moscow State Univ.). Prib. Tekh. Eksp., No. 4, 62-5(July-Aug. 1967). (In Russian).

The range of monoenergetic ion beams of ^{9}Be, ^{11}B, and ^{12}C with energy from 2 to 7.5 MeV in the photoemulsion NIKFI-YA2 was measured directly. The results agree with published experimental and theoretical data. (tr-auth)

6586 CHARACTERISTIC TEST OF RADIATION MONITORS OF RESEARCH REACTOR INSTITUTE OF KYOTO UNIVERSITY. Katsurayama, Yukinori; Tsujimoto, Tadashi (Kyoto Univ.). Hoken Butsuri, 2: 100-7(Mar. 1967). (In Japanese).

A characteristic test was performed for the radiation monitors installed in Research Reactor Institute of Kyoto University. All of these monitors are as follows: dust monitors, gas monitor, water monitors, area monitors of gamma-rays, area monitor of thermal neutrons, hand-foot-cloth monitors, and floor monitors. The performance tests of all equipment were almost satisfied except a part of the water monitors and the dust monitors. (auth)

6587 RELATIVE RESPONSES OF ORGANIC COMPOUNDS IN RADIOACTIVE IONIZATION DETECTOR. Takeuchi, Tsugio; Kobayashi, Kousuke. (Nagoya Univ., Japan). Kogyo Kagaku Zasshi, 70: 33-6(Jan. 1967). (In Japanese).

Relative responses of many organic compounds were measured by a radioactive ionization detector, where the influences of molecular weight and carbon number on the responses were also examined. The same relative molar response was obtained with a series of closely related compounds, such as n-aliphatic hydrocarbons, 2-methyl substituted aliphatic hydrocarbons, aromatic hydrocarbons and alcohols, even if their molecular weights are different from each other. Moreover, this trend was supported by a theoretical curve based on the assumption that the Penning Effect mainly occurred in the ionization chamber in comparison with other factors, such as ionization potential, the ionization cross-section area, the probability of recombination and the velocity of the collision between the test molecules and the metastable argon atoms. The relative molar responses, however, are different toward detectors. This comes from the differences in the radioactive source and the internal applied potential of each detector. Using the relative responses obtained, the determination of the components of the mixture in the same series was easily made within the range of experimental error. Also, the changes of the response itself and relative response, when the applied potential and the flow rate of carrier gas were changed, were examined and discussed. (auth)

6588 INVESTIGATIONS ON THE NUCLEAR COUNTER MEASURES ON THE BETA MEASUREMENTS BY THE SEMICONDUCTOR RADIATION DETECTOR. Kenmochi, Kazuo (Technical Research and Development Inst., Japan Defense Agency). Giho (Boeicho Gijutsu Kenkyu Honbu), 5: No. 35, 13-33(Jan. 1966). (In Japanese).

The specific ionization of beta-rays is considerably small, compared with other (heavy) charged particles, and so it is difficult to absorb all the energy within the narrow depletion region of a semiconductor detector. Consequently, it has been considered impossible to detect beta rays with this device. In the study it was shown that, with a semi-conductor detector, having its depletion region $\frac{1}{3}$ to $\frac{1}{4}$ as thick as the maximum range of the beta rays to be measured, the energy analysis of the beta-rays was possible with excellent resolution and fair linearness, indicating the prospect of its becoming a promising β-ray detector. Further, the feasibility of its use for x-ray and low-energy γ-ray detections was also shown. But, for the semiconductor detector to be applicable for the qualitative measurement of β rays, it is necessary to carry out qualitative experiments on the back scattering, minimum ionization, counting efficiency, etc. (NSA of Japan)

6589 OPTIMUM SHAPING OF THE COLLIMATOR IN SCINTIGRAPHS. Horvath, Lajos Finommechanika, 6: No. 3, 72-8(Mar. 1967). (In Hungarian).

The various characteristics of collimators employed in the scintiscanner technique are discussed including background radiation (zero effect), effectivity (sensitivity), resolving ability, shadow ratio, and overall factor. The determination of these characteristics for cylindrical collimators, conical collimators, and multichannel collimators is discussed. The characteristics for various types of collimator are compared on the basis of these considerations. The results permit the selection of optimum collimator configuration for the required measuring task. (A.T.D.)

6590 WHOLE-BODY COUNTERS. Miwa, H.; Yamamoto, Y. (Kobe Kogyo Corp., Japan). Kobe Kogyo Giho, No. 33, 72-9(July 1967). (In Japanese).

The high sensitivity whole body counter and the medical whole body counter, manufactured by Kobe Kogyo Corporation, which were delivered to the Research Reactor Institute of Kyoto University and to Medical Dept. of Nagoya University, respectively, are described. In the high sensitivity whole body counter the γ- (or x-) rays from a subject on the bed or chair are detected by large NaI (Tl) scintillators and their outputs recorded by a 400-channel analyzer. The vertical position is set manually and the scanning in the direction of the lying subject's length and width is done automatically. Despite the large size of the scintillators used, the energy resolution is high, 6.5% for ^{40}K and 9% for ^{137}Cs. In the medical whole body counter the characteristic features are no feeling of insecurity in its iron chamber and the measurements in good conditions, uniform and high detection-efficiency for each part of the human body by means of the radially set detectors, and measurement of the total body-activity by scanning in the direction of the patient's length, using the moving bed, and measurement of the activity distribution by means of the count (or count rate) at each part of the body. (NSA of Japan)

6591 PROPOSED STANDARD [FOR] CRITICALITY ACCIDENT ALARM SYSTEM. Savolainen, Ann W. (ed.). Nucl. Eng. Bull., 5: 1-7(Nov. 1967).

A standard for criticality accident alarm systems is presented by ANS. Included are criteria for system design, evacuation and emergency planning, and post-accident analyses. (W.H.K.)

6592 DETERMINATION OF THE ENERGY YIELD FROM BETA SOURCES BY MEANS OF GEIGER-MUELLER COUNTERS. Vukolov, V. I. Izmer. Tekh., No. 8, 70-2(Aug. 1967). (In Russian).

On the basis of the exponential character of the absorption of β radiation it was shown that at a given thickness of the window at the end of the counter, the counting rate can be proportional to the energy output of the source. Measurements with the counter of β sources ^{60}Co, ^{198}Au, ^{24}Na, ^{32}P, ^{90}Y, $^{144}Ce-^{144}Pr$, and ^{42}K are described. With the geometric factor of the measurement device $\omega = 0.0115$ and with thickness of the window of $t = 0.6$ kg/m^2 of aluminum for the range of average β sources from 0.5×10^{-13} to 2.3×10^{-13} J, the conversion coefficient from the counting rate N at the energy yield ϵ with error ±15% can be assumed constant and equal to $\phi = N/\epsilon = 4.5 \times 10^{10}$ pulse/J. For intense β sources $\phi' = \phi S/\omega' q = 1 \times 10^{9}$ pulses/J. (tr-auth)

6593 COLLECTION YIELD OF PHOTONS EMITTED IN A LIQUID SCINTILLATOR. Rosenstingl, E. (Faculte de Medecine et de Pharmacie, Toulouse); Commanay, L.; Godeau, A.; Blanc, D.; Teyssier, J. L. Nucl. Instrum. Methods, 58: 61-72(Jan. 1968). (In French).

Theoretical expressions are given for the collection yield of a cylindrical scintillator irradiated, either internally or externally and the values of the yield for a commonly used liquid scintillator. The results are tested experimentally. (auth)

6594 CALIBRATION OF A HYDROGEN BUBBLE CHAMBER AS A SPECTROMETER FOR LOW MOMENTUM ELECTRONS. Derenzo, S. E.; Hildebrand, R. H. (Univ. of Chicago). Nucl. Instrum. Methods, 58: 13-20(Jan. 1968).

A hydrogen bubble chamber has been calibrated at 7, 14, and 21 kG for low momentum electrons by measuring 0.5 MeV and 1 MeV internal conversion electrons from a ^{207}Bi source. The source was mounted on thin polyester strips which were suspended in the chamber. The two conversion lines are easily resolved at 7 and 14 kG but are only barely resolved at 21 kG. At 14 kG the 1 MeV line has fwhm, $\Gamma = 25\%$. The momentum calibration at this energy is good to <2%. The line shape is given by the function $(p/p_i)^{0.6}/(|p-p_i|^{2.6} + S^{2.6})$ where p_i is the true momentum and $S \approx 0.5\, p_i \Gamma$. The variation of Γ with momentum is found by supplementing the ^{207}Bi data with measurements of the high energy and of the μ-decay spectrum. Tests have been made for momentum dependent inefficiencies. (auth)

6595 LARGE LIGHT OUTPUT GAS PROPORTIONAL SCINTILLATION COUNTERS. Policarpo, A. J. P. L.; Conde, C. A. N.; Alves, M. A. F. (Univ., Coimbra). Nucl. Instrum. Methods, 58: 151-6(Jan. 1968).

The scintillating properties of the mixtures Ar-5% Xe and He-42.5% Xe are studied under the influence of a radial electric field. The secondary scintillation pulse, which is slow (~10 μs), has an amplitude that exceeds by a factor of 200–300 the pulse amplitude from standard CsI(Tl) and NaI(Tl) scintillators. This is an order of magnitude larger than the one from the previously reported argon proportional scintillation counter. This study is carried out for different conditions of pressure and electric field intensity, with and without wavelength shifter. The maximum pulse amplitude (with no higher order components) is, for the Ar-5% Xe mixture, independent of pressure. These mixtures have inherent interest for nuclear spectroscopy applications. (auth)

6596 FILM RECORDING RADIATION-EVENT MONITOR FOR PULSED X AND GAMMA RADIATION. Dyer, F. F.; Bate, L. C.; Thacker, L. H. (Oak Ridge National Lab., Tenn.). Nucl. Instrum. Methods, 58: 157-60(Jan. 1968).

A sentinel-type radiation detection device was developed to provide time stamped records of exposure to rapid pulses of X or gamma radiation. Radiation is detected by a CsI(Tl) scintillation crystal. Visible light generated in the scintillator is transmitted to a photographic film through a moving aperture in a mercury micro-coulometer and time reference scale to record the time of exposure. The detector responds satisfactorily to radiation pulses ranging from ~0.2 to ~50 mR with time durations from several nsec to several min. Full-scale timing intervals can be adjusted from a few hours to several months. Exposure records can be read to within 0.1% of the full-scale timing interval. (auth)

6597 SELF SHIELDING AND SELF ABSORPTION IN GOLD FOILS. Ilberg, D.; Segal, Y. (Technion-Israel Inst. of Tech., Haifa). Nucl. Instrum. Methods, 58: 161-3(Jan. 1968).

The apparent beta and gamma activity of a gold foil as a function of its thickness is calculated and measured. The problem of optimum foil thickness for neutron flux measurement is discussed. It is shown that under certain conditions the counting rate is not proportional to foil thickness and can even decrease as the thickness increases. This effect must be considered when foils of varying thicknesses are used for flux mapping. (auth)

6598 INFLUENCE OF GEOMETRIC FACTORS ON PROBLEMS IN THE MEASUREMENT OF RADIATION FIELDS. Prochazka, W.; Bensch, F. (Atominstitut der Osterreichischen Hochschulen, Vienna). Nucl. Instrum. Methods, 58: 117-24(Jan. 1968). (In German).

The influence of geometric factors on problems in the measurement of radiation fields is considered. Field sources and probes are often assumed to be point-shaped in problems of field physics. The probes correspond to certain measurable quantities. In many situations in which field source or/and probe (test object) are not point-shaped, we may assume that deviation of the measurements from the idealized case mentioned above depends exclusively upon geometric factors. Approximate solutions are discussed and explicitly presented for several geometric configurations under said assumption. (auth)

6599 PULSE-SHAPE-DISCRIMINATION CIRCUIT OF WIDE RANGE AND HIGH SENSITIVITY. Johnson, F. A. (Defence Chemical, Biological and Radiation Establishment, Ottawa). Nucl. Instrum. Methods, 58: 134-42(Jan. 1968).

A sensitive pulse-shape-discrimination circuit of wide range is described. The circuit measures the time between the initial rise and the crossover of the doubly differentiated voltage pulse from one of the lower dynodes of a photomultiplier and provides an analog output. Two tunnel diodes which undergo similar forward transitions are employed to determine the two times of interest. Examples of the output of the circuit when used with a stilbene scintillator are given. (auth)

6600 LOW-PRESSURE HELIUM SPARK CHAMBERS. Bunaciu, T.; Kullander, S. (CERN, Geneva). Nucl. Instrum. Methods, 58: 173-5(Jan. 1968).

A spark chamber filled with a mixture of helium and alcohol vapor was exposed to 5.3-MeV α particles and 0.5-MeV β particles. The lowest pressure at which one can obtain defined sparks, was very dependent on gap size and alcohol concentration. With a gap of 1.6 cm and an alcohol concentration of 20% this pressure was 30 Torr. The spatial resolution, measured by means of the current-read-out method, was of the order of 1 mm. The efficiency for α particles was always close to 100%. (auth)

6601 INSTRUMENTATION TO MEASURE THE RATIO OF NEUTRON CAPTURE TO FISSION CROSS SECTIONS AT keV NEUTRON ENERGIES. Todd, J. H.; Weston, L. W.; Ingle, R. W. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Nucl. Instrum. Methods, 58: 143-50(Jan. 1968). (ORNL-P-3956).

Instrumentation for measurement of α (the ratio of the neutron capture cross section to the fission cross section) was designed, assembled, and calibrated, and measurements were made for ^{239}Pu, ^{233}U, and ^{235}U at neutron energies from 10 to 600 keV. The detector consisted of eight photomultiplier tubes located around the periphery of a 210-gal tank of gadolinium-loaded liquid scintillator. The time resolution of the system was 6.5×10^{-9} sec under operating conditions. The energy resolution at the 2.5-MeV sum peak of ^{60}Co was 35%. Neutron energies were measured by time-of-flight techniques using a flight path of 1 meter. Fission events were distinguished from capture events by the detection of thermalized fission neutrons following the primary events. Measurement of the relative efficiency of the large scintillator tank for detecting capture and fission events was made by simultaneously compiling the background and foreground pulse-height spectra for both the capture and fission events. Typical spectra for the neutron time of flight for capture and fission events along with the background and foreground spectra or both types of events are shown. The techniques and adjustments used to obtain the timing resolution on the large tank are discussed. The logic necessary for distinguishing fission events and the foreground and background pulse-height spectra associated with both types of events are described. (auth)

6602 AUTOMATIC TRACE OF ENERGY-LEVEL FOR PROCESSING A STATISTICAL MATRIX A(I,J). Kamoun, R.; Faucon, A.; Gluzman, P. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Instrum. Methods, 58: 45-56(Jan. 1968). (In French).

Starting with a smoothing operation this processing was found adequate for an A(I,J) matrix where A is the number of nuclear events corresponding to two correlated parameters (e.g. energies), as in particle-gamma correlation experiments. (auth)

6603 GREY NEUTRON DETECTOR FOR THE INTERMEDIATE ENERGY REGION. Poenitz, W. P. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods, 58: 39-44 (Jan. 1968).

A neutron detector for the accurate measurement of relative neutron flux intensities in the keV energy region is described. The detector consists, in its simplest arrangement, of a paraffin pile and a NaI(Tl) detector to detect the 2.2 MeV capture γ-rays. The efficiency curve is relatively flat in the considered energy range. The efficiency curve depends only slightly on a change in the parameters used for its calculation. The application of the detector in neutron cross section experiments is described. (auth)

6604 DETECTION EFFICIENCY OF A PLASTIC SCINTILLATOR FOR 10 TO 70 MeV NEUTRONS. Brady, F. P.; Jungerman, J. A.; Young, J. C.; Romero, J. L.; Symonds, P. J. (Univ. of California, Davis). Contract AT(11-1)-gen-10. Nucl. Instrum. Methods, 58: 57-60(Jan. 1968). (UCD-CNL-59).

The neutron detection efficiency of a plastic scintillator 30.5 cm long and 12.7 cm in dia. has been measured for neutron energies from about 10–70 MeV. These were obtained by scattering a 193 MeV neutron beam from a liquid hydrogen target. A telescope selected protons from the n-p scattering which then determined the energy and flux of neutrons in the conjugate solid angle. A known fraction of this flux was intercepted by the neutron detector and the efficiency was thus determined. For a threshold near 1 MeV the efficiency is nearly constant from 20–50 MeV, then it decreases slowly with increasing neutron energy. As expected thresholds two and four times larger decrease the efficiency, particularly at low energy. (auth)

6605 COUNTING AND CAMPBELLING: A NEW APPROACH TO NEUTRON-DETECTION SYSTEMS. Popper, Glenn F. Reactor Fuel-Process. Technol., 10: 199-207 (Summer 1967).

The Campbelling neutron-detection system, or mean-square voltage system, is described. Design and performance of Campbelling detection systems using fission-chamber detectors and ionization-chamber detectors are presented. The system shows promise for reactor in-core monitoring of neutron flux. (W.H.K.)

6606 ELECTRONIC APPARATUS ASSOCIATED WITH A 4π COUNTER OPERATING IN THE PROPORTIONAL REGION FOR ABSOLUTE COUNTING OF β EMITTERS. Vatin, R. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Nucl. Instrum. Methods, 57: 267-70(Dec. 1967). (In French).

An electronic device used in conjunction with a 4π proportional counter for the standardization of β emitters is described. This apparatus, in the form of a RENATRAN unit, comprises a current pulse amplifier shielded by current limiters and an improved dead time circuit shielded by an electronic gate. It can operate at counting rates of up to 12×10^6 ppM. (auth)

6607 HIGH-PRESSURE GAS SCINTILLATION DETECTORS WITH POSITION-INDEPENDENT PULSE HEIGHT. Hentschel, G.; Mack, G.; Tornow, W. (Univ., Tuebingen, Ger.). Nucl. Instrum. Methods, 57: 257-60(Dec. 1967). (In German).

A high pressure gas scintillator of large volume (400 cm^3) is described, the pulse height of which is independent of the point of scintillation within 2%. This is accomplished by the use of two photomultipliers in coincidence. Additionally, the best performance of gas composition, reflectors and thicknesses of the wave length shifter on the wall and on the windows is reported. (auth)

6608 MULTIDETECTOR APPARATUS FOR LINEAR POLARISATION CORRELATION MEASUREMENTS. Weigt, P.; Huebel, H.; Goettel, P.; Herzog, P.; Bodenstedt, E. (Univ., Bonn). Nucl. Instrum. Methods, 57: 295-312(Dec. 1967).

A nine detector apparatus for the measurement of linear polarization correlations of gamma-gamma-cascades is described. The high statistical accuracy which can be obtained with this apparatus requires a reinvestigation of the solid angle correlation. A modified approximation of the solid angle correlation is developed and its performance is checked by careful calibration measurements with the isotopes ^{106}Pd, ^{46}Sc and ^{60}Co. The theory of the attenuation of linear polarization correlations by internal fields is developed. (auth)

6609 THE EFFECT OF A WAVE-LENGTH SHIFTER ON THE LIGHT OUTPUT OF THE Ar–N_2 PROPORTIONAL SCINTILLATION COUNTER. Alves, M. A. F.; Policarpo, A. J. P. L. (Univ., Coimbra). Nucl. Instrum. Methods, 57: 321-4(Dec. 1967).

The use of a wave-length shifter gives an increase of more than one order of magnitude in the light output of an Ar proportional scintillation counter. Its effect in Ar – N_2 mixtures is studied. (auth)

6610 USE OF GOLD COATED QUARTZ FIBRES IN HIGH PRESSURE PROPORTIONAL COUNTERS. Adams, R. J. (National Research Council, Ottawa). Nucl. Instrum. Methods, 57: 351-2(Dec. 1967).

Gold coated quartz fibres may successfully replace stainless steel anodes in 4π high pressure counters. Resolution is improved due to a reduction in surface roughness. (auth)

6611 CRYOSTAT FOR Ge(Li) DETECTORS WITH AUTOMATIC REFILLING FROM A COOLING RESERVOIR. Marten, R. (Gesellschaft fuer Kernenergieverwertung in Schiffbau and Schiffahrt, Geesthacht, Ger.). Nucl. Instrum. Methods, 57: 274-6(Dec. 1967). (In German).

A miniature cryostat for cooling Ge(Li)-detectors with liquid N_2 is described. It is refilled through a flexible tube from a supply dewar by means of an automatically operating device. (auth)

6612 POINT ANODE PROPORTIONAL COUNTERS FOR THE DETECTION OF SOFT X RAYS IN MICROANALYSIS. Ranzetta, G. V. T.; Scott, V. D. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Sci. Instrum., 44: 983-7(Dec. 1967).

An end-window (point anode) counter is described which has been designed for detecting soft x rays in an electron-probe microanalyzer. An experimental evaluation of the counter showed that it had good resolution for the x-ray wavelength range encompassing CK, OK and AlK, provided that the needle-to-window distance and the x-ray aperture size were both suitably selected. The deterioration in counter performance when the optimum geometrical settings were not used was found to be due to a spread in mean pulse energies, which could reach 40%, arising from ionizations across the counter axis. The best resolution figures achieved during practical operation of this end-window counter, and a larger model of similar design, were $\sigma/\overline{P}$ = 20%, 42% and 64% for AlK, OK and CK x rays, respectively, as compared with 15%, 35% and 46%, measured on a standard side-window design. These values are far inferior to suggested theoretical resolutions, and methods of improving the counters are considered. It is concluded that a good side-window counter, with its superior resolution, is desirable for quantitative microanalysis using the network method, but other cases are discussed where the end-window counter may be preferred on account of its convenient geometry. (auth)

6613 ELECTRONIC PROPERTIES OF PARTICLE-COUNTING DIAMONDS. I. PHOTOCONDUCTIVITY. Vermeulen, L. A.; Nabarro, F. R. N. (Univ. of the Witwatersrand, Johannesburg). Phil. Trans. Roy. Soc. London, Ser. A, 262: 251-98 (Oct. 6, 1967).

An account is given of an experimental investigation into the photoconductivity of particle-counting diamonds at room temperature and at 80°K. Photoconduction spectra were obtained in the range 2500 to 200 nm, which are typical of type Ia diamonds. The room temperature spectra are characterized by a system of eight photoconduction peaks. The peaks are attributed to the intrinsic absorption, the thermal decomposition of excitons and the excitation of three levels in the forbidden energy gap at 0.85, 1.45 and 2.2 eV from the valence band. This model is consistent with the known electro-optical properties of type Ia diamonds. The model is formulated mathematically and formally shown to predict the observed photoconduction responses of the diamonds to certain characteristic illuminations. (auth)

6614 MINIMALIZATION OF THE FLUCTUATION COEFFICIENT IN GASES USED IN CHARGED PARTICLE SPECTROMETER. Pawlowski, Zdzislaw (Warsaw Polytechnic Inst.). Nukleonika, 12: 913-25(1967). (In Polish).

The aim of the investigations was to obtain a gas mixture with a minimum fluctuation coefficient. In these studies use was made of the Fano–Worobjew theory. A pulse ionization chamber was used with argon as the main gas component. The investigations have lead to obtaining gas mixtures with fluctuation coefficients lower than that of pure argon. (auth)

6615 PREPARATION OF CYLINDRICAL COAXIAL-DRIFTED GERMANIUM DETECTORS WITH LARGE ACTIVE VOLUME. Meyer, O.; Baumgaertner, M.; Wuechner, F. (Kernforschungszentrum, Karlsruhe). Nukleonik, 10: No. 4, 189-92(1967). (In German).

A detailed description of construction and performance of coaxial Li-drifted germanium detectors with active volumes between 20 and 40 cm^3 is given. Doppler-open end detectors with circular cross section show a smaller distribution in rise time than detectors with trapezoidal cross section or detectors with one open end. The energy resolution (3.3 keV for E_γ = 661 keV) is comparable with the energy resolution of planar drifted detectors. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 6270, 6717, and 7764.

6616 (BMwF-FBK-67-71) MESSUNG VON BETA-SPEKTREN MIT EINEM MAGNETISCHEN, EISENFREIEN β-e-KOINZIDENZ-SPEKTROMETER. (Measurement of β-Ray Spectra Using a Magnetic Ironfree β-e Coincidence Spectrometer). Fritsch, F. (Technische Hochschule, Brunswick (West Germany). Institut A fuer Physik). Aug. 1967. 42p. (In German). Dep.

The construction and the properties of the coincidence spectrometer are described. A correction formula is derived which accounts for the distortion of the primary spectrum, caused by the measurement itself. The relevant parameters of this correction formula are determined by test and calibration measurements. Finally, the results of coincidence measurements on β-transitions of ^{141}Ce and ^{144}Ce are reported. For the end point energies of the low energy transitions in these nuclei the values (439.4 ± 2.07) keV for ^{141}Ce and (177 ± 2) keV for ^{144}Ce are obtained. Both transitions have allowed shape. (auth)

6617 (ORNL-tr-1816) CALCULATION OF THE PULSE-HEIGHT DISTRIBUTION IN GAMMA SPECTROMETRIC MEASUREMENTS MADE BY MEANS OF GERMANIUM DETECTORS. Gonidec, J. P.; Walter, G.; Coche, A. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Nucl. Instrum. Methods, 53: 185-91(1967). 10p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Taking advantage of the good energy resolution and linearity of germanium lithium-drift detectors, we describe a method for the calculation of pulse height distributions observed with these spectrometers for monoenergetic γ rays. This discussion includes the main types of interactions: photoelectric, single and double Compton effects for incident photons and for radiations scattered from surrounding materials. The resulting calculated gamma ray shapes are compared with experimental spectra, the detector considered was a coaxial device with a sensitive volume of 20 cm^3. (auth)

6618 4π β–γ COINCIDENCE TECHNIQUE FOR THE STANDARDIZATION OF RADIONUCLIDES AT AEET. Srivastava, P. K.; Khera, G. D. (Atomic Energy Establishment, Trombay, India). pp 154-66 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966. See CONF-660341.

The design and techniques of the 4π β–γ coincidence system for the standardization of radionuclides are presented. The correction factors involved in calculating the disintegration rate are also discussed. (W.H.K.)

6619 USE OF GAMMA-RAY SCINTILLATION SPECTROMETER IN THE ANALYSIS OF URANIUM AND THORIUM ORES. Rai, Lajpat (AMD Lab., New Delhi). pp 251-60 of Proceed-

ings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

Techniques for the analysis of uranium and thorium ores using a gamma-ray scintillation spectrometer are presented. The advantages and accuracies of these techniques are also discussed. (W.H.K.)

6620 EFFECT OF ABSORBERS ON ALPHA SPECTRAL MEASUREMENTS. Nambiar, P. P. V. J.; Gopinath, D. V. (Atomic Energy Establishment, Trombay, India). pp 477-92 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

The spread in the alpha spectrum due to different absorbers between the source and the detector is studied. A comprehensive mathematical treatment is presented, and experimental methods are explained. A comparison of the experimental spectra is made with the spectra obtained with computed values. (W.H.K.)

6621 A HIGH-SENSITIVITY SPECTROMETER FOR MEASURING LOW-ENERGY X-RAYS. Leger, C.; Bibron, R.; Labeyrie, J.; Delibrias, G. (Centre d'Etudes Nucleaires, Saclay, France). pp 629-38 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

A proportional counter for measuring low-energy x rays is described. Information is given on the main characteristics of the counter, viz. linearity, detection efficiency, resolving power and background. The apparatus described was used to determine the concentrations of x emitters contained in two meteorites which recently fell in France: The Granès meteorite (13 November 1964) and the Saint-Séverin meteorite (27 June 1966). (auth)

6622 EXTREMELY LOW-LEVEL SCINTILLATION SPECTROMETER. Sonntag, C. (Univ. of Heidelberg). pp 675-86 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

A 4 in. × 4 in. NaI(Tl) gamma spectrometer with an extremely low background of 120 cpm above 30 keV is described. The γ' detection limit for material in the 2-liter sample container surrounding the crystal ranges between 0.3 and 0.8 dpm over the spectral range from 0.1 to 3 MeV. The spectrometer was used for the measurement of low gamma activities, such as those due to small traces of impurities in various materials, and in searches for the decay of extremely long-lived naturally occurring isotopes, such as vanadium-50 (fourfold forbidden β transition, lower limits of half-life found to be 9×10^{16} and 6.9×10^{16} yr for the two modes of decay), calcium-48, nickel-58 and tellurium-130 (double β decay, half-life limits found for these three nuclides being 2.0×10^{16}, 2.4×10^{19} and 1.6×10^{18} yr, respectively). Recently the spectrometer was used for meteorite measurements. For the better detection of positron emitters, the spectrometer was extended by a $\gamma\gamma$-coincidence system by the addition of an ordinary 3 in. × 1½ in. NaI crystal. The detection efficiencies for annihilation radiation, ^{22}Na and ^{26}Al are 0.3, 0.7 and 0.8 dpm respectively. In the St. Séverin meteoritic material 16.8 dpm ^{40}K(933 ppM K), 10.7 dpm ^{54}Mn, 9.1 dpm ^{22}Na and 5.8 dpm ^{26}Al per 100 g were found. The material of Esebi contains 11.5 dpm ^{40}K (638 ppM K) and 6.1 dpm ^{26}Al per 100 g. (auth)

6623 ANTICOINCIDENCE SHIELDED MULTIDIMENSIONAL GAMMA-RAY SPECTROMETERS FOR LOW-LEVEL COUNTING. Nielsen, J. M.; Perkins, R. W. (Battelle-Northwest, Richland, Wash.). pp 687-701 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

Multidimensional gamma-ray spectrometry is a new technique for the measurement of many gamma-ray-emitting radionuclides which allows their direct identification and measurement in complex mixtures of radionuclides in diverse sample matrices without prior chemical treatment. Great selectivity is obtained by providing an additional parameter of separation for those radionuclides which decay through the emission of two or more gamma rays in cascade. The spectrometer measures the energies of these coincident gamma rays and stores the values obtained uniquely in the electronic memory according to the energy lost by each of them in the two primary crystals of the detector. Measured events from radionuclides which decay by single or non-coincident gamma-ray emission are stored according to the single parameter of energy lost in one of the primary crystals. This greatly improves the selectivity while effectively decreasing the background and Compton event interference. Through the use of anticoincidence shielding and special detector selection and design the high sensitivity necessary for low-level counting has been obtained. To achieve high efficiency, large detectors capable of accepting large samples in a near 4π geometry are used to approach a total absorption detector system. An anticoincidence shield, consisting of an annular detector of thallium-activated sodium iodide, or plastic phosphor, encloses the two primary detectors. This shield reduces the background by eliminating from analysis cosmic-ray or other events occurring simultaneously in the principal detectors and the shield, as well as reducing the interference from those events wherein full energy absorption of the gamma ray does not occur in the principal detector, and the degraded photon from this Compton event interacts with the shield crystal. Performance capabilities have been determined of several multidimensional gamma-ray spectrometers with primary detectors of NaI(Tl) as large as 11 in. dia by 6 in. thick and with anticoincidence shields of plastic phosphor as large as 36 in. dia by 36 in. thick. Applications of these instruments to the natural or induced radionuclides useful in radioactive dating in meteorological, oceanographic and sedimentation studies are discussed. (auth)

6624 STABILIZER OF THE MAGNETIC FIELD OF BETA SPECTROMETERS. Kuklik, A. (Inst. of Nuclear Research, Rzhezh, USSR). Prib. Tekh. Eksp., No. 4, 157-62(July-Aug. 1967). (In Russian).

A device for the stabilization and measurement of the intensity of the magnetic field up to 350 Oersted with a sensitivity of 1×10^{-3} Oersted was described. The magnetosaturated probe with doubling of the frequency was used as an indicator of the deviation of the magnetic field from the given values. The field sets the size of the current in the solenoid. The stability is 0.01% in fields of 10 Oersteds. The device was used for the measurement and stabilization of magnetic fields from 10 to 350 Oersteds in the iron β-spectrometer with resolution of 0.1%. (tr-auth)

6625 STABILIZATION OF THE SCINTILLATION SPECTROMETER BY MEANS OF A MULTICHANNEL AMPLITUDE ANALYZER. Murzin, A. V.; Tuchinskii, M. M. (Inst. of Physics, Kiev). Prib. Tekh. Eksp., No. 4, 40-3(July-Aug. 1967). (In Russian).

In order to stabilize the amplification of pulses in scintillation spectrometers between the photomultipliers and the multichannel analyzers, a circuit was used which guarantees the position of the bearing peak from a TKH–4B light source in a given channel of the analyzer. The circuit provides for stability of the position of spectral lines from a radioactive source with a precision of 0.2% during 24 hrs of continuous operation. (tr-auth)

6626 USE OF SCINTILLATION GAMMA SPECTROMETER WITH PROTECTIVE COATING FOR MEASUREMENT OF THE SPECTRA OF GAMMA RAYS FROM THE RESONANCE CAPTURE OF NEUTRONS. Belyaev, F. N.; Ignat'ev, K. G.; Soldatov, A. N. Prib. Tekh. Eksp., No. 4, 37-9(July-Aug. 1967). (In Russian).

A description was given of the operation of the scintillation γ spectrometer in two regimes: with anticoincidence and with coincidence. Measurements were made on the spectra of γ rays emitted during the resonance capture of neutrons by ^{108}Pd and ^{198}Pt. Separate intense γ transitions were separated in the measured spectra. (tr-auth)

6627 ON THE RELATION BETWEEN THE γ RAY SPECTRUM AND THE WINDOW WIDTH OF THE PULSE HEIGHT ANALYZER. Uemura, Teiji (Ind. Res. Inst., Osaka Prefecture). Osaka Furitsu Kogyo Shoreikan Hokoku, No. 40, 91-2(Dec. 1966). (In Japanese).

In the measurement of a gamma-ray spectrum, it is necessary to select the proper window width of the single-channel pulse-height analyzer and also the proper gain of the linear amplifier, in order to increase the resolution as much as possible. An investigation was made of the optimum values of the two for a 0.662 MeV photo peak with a 1¾ in × 2 in NdI(Tl) crystal and 1 mc ^{137}Cs. It appeared that the resolution was improved by increasing the gain and reducing the window width. But when the latter is made too small the count rate is reduced leading to poor accuracy. The optimum window width was found to be 0.3 times the half-width of the photo peak, or less. (NSA of Japan)

6628 ABOUT THE DETERMINATION OF SLOW-NEUTRON RESONANCE PARAMETERS. Coceva, C.; Corvi, F.; Giacobbe,

P.; Stefanon, M. (Comitato Nazionale Energia Nucleare, Ispra, Italy). Nucl. Instrum. Methods, 58: 1-12(Jan. 1968).

Methods of analysis of neutron transmission data in time-of-flight spectrometry are examined, with particular attention to the experimental conditions which should be satisfied for a correct estimation of resonance parameters and errors. To improve the applicability of the shape-analysis method in the work performed with the fast neutron chopper of Ispra, the resolution function of this spectrometer was determined in a detailed way. The main features of the analysis methods applied to the experimental data obtained at Ispra are presented and illustrated by examples. (auth)

6629 DOUBLE CRYSTAL DIFFRACTION SPECTROMETER FOR STUDIES OF HIGH ENERGY GAMMA-RAYS RESULTING FROM THERMAL NEUTRON CAPTURE. Alexeev, V. L.; Shaburov, V. A.; Kaminker, D. M.; Sumbaev, O. I.; Smirnov, A. I. (Ioffe Inst. of Physics and Tech., Leningrad). Nucl. Instrum. Methods, 58: 77-83(Jan. 1968).

A double flat crystal diffraction gamma spectrometer designed on the basis of a 4-m Cauchois focusing instrument with scintillation counting, developed before by the authors is described. The spectrometer is designed for studies of high-energy gamma spectra from the (n,γ) reaction. Gamma-rays whose energies are within the neutron binding energy range for a number of nuclei have been recorded. The instrument resolution for diffraction from the (211) planes of 52 mm thick calcite crystals in the range of E = 0.5 to 6 MeV is $\Delta E/E = 0.2$ to 0.8%. The spectrometer enables us to make use of the sources featuring neutron capture cross sections over several barns. The instrument parameters were investigated in the $^{35}Cl(n,\gamma)^{36}Cl$ reaction. The experimental data are compared with the results of the calculations performed. (auth)

6630 NEUTRON-GAMMA DISCRIMINATING DETECTOR FOR USE WITH TIME-OF-FLIGHT FAST NEUTRON SPECTROMETER. Hiramoto, T.; Nohara, N. (National Inst. of Radiological Sciences, Chiba, Japan). Nucl. Instrum. Methods, 58: 167-9(Jan. 1968).

The pulse shape discrimination of space charge saturation type is applied to a TOF fast neutron detector. An external capacitor is added to the last dynode to shift the dynamic range to higher current density side so that operating the photomultiplier tube at high gain is possible. (auth)

6631 THE CALIBRATION OF A Ge(Li) GAMMA-RAY SPECTROMETER FOR ENERGY AND RELATIVE INTENSITY MEASUREMENTS. Donnelly, D. P.; Baer, H. W.; Reidy, J. J.; Wiedenbeck, M. L. (Univ. of Michigan, Ann Arbor). Nucl. Instrum. Methods, 57: 219-26(Dec. 1967).

Two aspects of Ge(Li) gamma-ray spectrometry are discussed. The nonlinearity of an amplifier–analyzer system was measured using a precision pulser and was checked with gamma-ray standards. The overall accuracy was 2 parts in 10^4. The relative detection efficiency of gamma-ray full-energy peaks was determined using sources with well measured relative gamma-ray emission rates. Two Ge(Li) detectors with active volumes of 3 $cm^2 \times 0.5$ cm and 4 $cm^2 \times 0.5$ cm were calibrated in the energy range 80-3200 keV. An overall accuracy of 5% in the energy region from 500-3200 keV and an accuracy of 10% over the entire range were obtained. The relative areas of the single escape peak and double escape peak to the full energy peak as a function of energy are included. The relative intensities of the 569.6, 1063.6 and 1771 keV gamma-rays following the decay of ^{207}Bi were measured. (auth)

6632 DECAY DEPENDENT BACKGROUND SIGNALS IN A MAGNETIC ELECTRON SPECTROMETER. Kleinheinz, P.; Vukanovic, R.; Samuelsson, L.; Zupancic, M.; Krmpotic, D.; Besev, C.; Siegbahn, K. (Univ. of Uppsala). Nucl. Instrum. Methods, 57: 181-96(Dec. 1967).

Scattering of the radiation emitted in a radioactive decay at the constructional components of a magnetic spectrometer will give rise to a background which usually is not eliminated by coincidence techniques. The background spectrum depends upon the features of the decay under investigation, the instrumental settings and the design parameters of the spectrometer. The origin and intensity of various types of background signals observed in a magnetic lens spectrometer were investigated. Quantitative representative results are given which can provide an order of magnitude estimate for the background intensity to be expected in a certain decay. Significant background intensities are caused by γ-radiation as well as by electrons emitted in the decay. It was found that scattered conversion electrons can give rise to sharp structures in the apparent electron spectrum, which are comparable to or even narrower than the instrumental resolution. It is shown by which counter measures the various types of backgrounds can be minimized. (auth)

6633 A BETA SPECTROMETER ARRANGEMENT FOR MEASURING CONVERSION ELECTRON SPECTRA FROM (n,γ) REACTIONS. Backlin, A. (Univ. of Uppsala. Swedish Research Council's Lab., Studsvik). Nucl. Instrum. Methods, 57: 261-6 (Dec. 1967).

A 50 cm radius double focusing beta spectrometer for measuring (n,e^-) spectra has been installed at the Studsvik R2 reactor. The equipment forming the neutron beam and the target and detector arrangements are described. In comparison with the earlier spectrometer arrangement at the R1 reactor the sensitivity has been increased more than 20 times. (auth)

6634 ANALYSIS OF MULTI-CHANNEL GAMMA RAY SPECTROMETER DATA WITH ADJUSTMENT FOR GAIN AND BASELINE DISCREPANCIES. Liuzzi, A.; Pasternack, B. S. (New York Univ., N. Y.). Nucl. Instrum. Methods, 57: 229-236(Dec. 1967). (TID-24159).

A method is presented for correcting gain and baseline discrepancies based upon transforming reference pulse-height distributions until a best least-squares regression fit is obtained; the method does not require the use of an extraneous reference source to establish the energy scale. A modification in the correction method is utilized for a procedure to obtain libraries of reference pulse-height distributions which are internally consistent in gain and baseline. (auth)

6635 DETECTOR FOR NEUTRON TIME-OF-FLIGHT SPECTROMETRY WITH IMPROVED RESPONSE TO LOW ENERGY NEUTRONS. Wishart, L. P.; Plattner, R.; Cranberg, L. (Univ. of Virginia, Charlottesville). Nucl. Instrum. Methods, 57: 237-44(Dec. 1967).

Design and operating characteristics are described of a neutron detector based on coincident detection of proton-recoil scintillations. Large area, compact construction, and efficient operation at neutron energies in the range of tens of keV are major features. A light output curve for proton energies down to 50 keV is reported, together with absolute photoelectric yields at several proton energies. (auth)

6636 DESIGN OF A NUCLEAR REACTION PARTICLE ANALYZER. Nakanishi, N.; Matsuda, K. (Inst. of Physical and Chemical Research, Yamato, Japan). Nucl. Instrum. Methods, 57: 245-51(Dec. 1967).

A magnetic analyzer for nuclear reaction particles has been designed. It is composed of two magnets, which have homogeneous magnetic fields and curved pole boundaries. Such a complex configuration is needed for various requirements in the ion optical properties. The two-directional focusing is approximately achieved. The higher-order term of the horizontal focusing is reduced by a trial and error calculation with a computer. The energy range covers from E_{max} to $0.67E_{max}$. The average energy resolution calculated is less than 1×10^{-3}, when the solid angle is 2.5×10^{-3} sterad. The vertical magnification is about 2 and the dispersion factor about 6. With these values and other properties, the design is suitable for the detection with an array of multiple detectors. The method of calculation is also described. (auth)

6637 HIGHLY FOCUSING BETA SPECTROMETER. Balzer, R.; Bharucha, D. S.; Heinrich, F.; Hofmann, A. (Swiss Federal Inst. of Tech., Zurich). Nucl. Instrum. Methods, 57: 277-94(Dec. 1967).

The design and construction of a double focusing β-spectrometer based on the properties of a field varying as $H = H_0 a/(r \sin \vartheta)$ is described. With a choice of suitable parameters, the characteristics of the instrument were investigated for particles performing six trochoidal revolutions. For various initial conditions, the aberrations in the focusing and the line profile were numerically evaluated. The calculations show that for extended sources, the instrument possesses a transmission of 1.87% which remains constant over a relatively large range of the resolution, $\delta p/p$; at $\delta p/p = 10^{-4}$, the value of the transmission amounts to 1.3%. The calculations formed the basis of the construction of a β-spectrometer having conical iron pole-pieces, maximum radius of the electron orbits being 25 cm. The experimental qualities of the spectrometer were examined in the energy range of 75 to 660 keV. The results confirm the theoretical predictions to a large extent. Deviations in the value of the transmission at high resolutions can be interpreted by the disturbing effects of residual errors present in the field. The highest resolution attained was $\delta p/p = 3.5 \times 10^{-4}$; at $\delta p/p = 5 \times 10^{-4}$, the value of the transmission has been measured to be 0.68%; the corresponding value of the luminosity is 2×10^{-4} cm^2. The experimental results show that for $\delta p/p \geq 5 \times 10^{-4}$, this instrument possesses values of the transmission and luminosity exceeding those values of existing double focusing spectrometers. (auth)

6638 COUNTER-TELESCOPE CONSISTING OF TANDEM PROPORTIONAL COUNTERS AND A LITHIUM-DRIFTED SILICON DETECTOR FOR CHARGED PARTICLES PRODUCED WITH

FAST NEUTRONS. Shirato, S.; Koori, N. (St. Paul's Univ., Tokyo). Nucl. Instrum. Methods, 57: 325-37(Dec. 1967).

A detailed description and characteristics are given of a counter-telescope for measuring precisely the energy and angular distributions of charged particles emitted in fast neutron-induced reactions. The counter-telescope consists of three identical gas proportional counters followed by a lithium-drifted silicon detector, in application of the Igo and Eisberg method. The counter-telescope has been successfully used for the measurement of recoil deuterons and breakup protons from deuterons bombarded with 14.1 MeV neutrons. The preliminary data on the D(n,p)2n reaction are also presented. (auth)

6639 GAMMA-RAY SPECTROMETRIC BORE-HOLE LOGGING DEVICE AND FIRST RESULTS OF ITS APPLICATION. Gerstenberger, W.; Loetzsch, W. Isotopenpraxis, 3: 375-9 (Sept. 1967). (In German).

A device is described enabling the record of gamma-ray spectra in bore-holes up to 1500 m of depth. After presetting definite pulse height intervals, the intensities are digitally recorded as a function of depth for three intervals of pulse height in continuous measurement. The spectrometric properties of the device (energy resolution, background in neutron-capture gamma-ray spectrometry) and first results of prospecting iron-bearing formations are discussed. (auth)

6640 MECHANICAL SELECTOR OF NEUTRON VELOCITIES. Krasnicki, Szezesny; Dec, Jerzy; Rapacki, Henryk (Inst. of Nuclear Physics, Krakow). Nukleonika, 12: 877-85 (1967).

The construction of a mechanical high transmission selector of neutron velocities is described. The monochromator is designed to cooperate with the neutron crystal spectrometer as a "cleaner" of the "monoenergetic" neutron beam contaminated with higher-order reflections. The results obtained during the testing period are given. (auth)

High Energy Physics Instrumentation

6641 (INFN/AE-66/6, pp 1-20) MAGNETOSTRICTION WIRE SPARK CHAMBERS. Bradamante, F.; Sauli, F. (Istituto Nazionale di Fisica Nucleare, Trieste (Italy)).

A brief review of the magnetostriction phenomenon is presented which includes topics such as the Joule effect, Villan effect, and domain theory. A discussion of pulse propagation along magnetostriction delay lines is included. Finally, the application of the magnetostriction concept to spark chambers is also presented. (B.G.D.)

6642 (LAL-1182) ETUDE D'UN APPAREILLAGE PERMETTANT LA MESURE DE LA DIFFUSION DES ELECTRONS A 180^0. (Study of an Apparatus for Measurement of Electron Scattering at 180^0). Ganichot, D.; Benaksas, D.; Grossetete, B.; Isabelle, D. B.; Lorrain, J. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Nov. 1967. 23p. (In French). Dep. CFSTI.

An experimental set-up was built for electron scattering studies at 180°. The optical properties of the system were determined from field mapping. As a check an experiment was performed on hydrogen and it was found that the tail of the elastic peak was modified due to the presence of background electrons. This set-up, as with all other systems for measuring electron scattering at 180°, includes an auxiliary magnet which is responsible for this background. This effect was demonstrated and could be eliminated. Conclusions are drawn about the general technique of such experiments. (auth)

6643 (UCRL-17623) DELAY-LINE MULTIPLEXING METHOD FOR STORAGE AND DISPLAY OF INFORMATION FROM MAGNETOSTRICTIVE SPARK CHAMBERS. Van Tuyl, Rory L.; Perez-Mendez, Victor; Lee, Kai; Grove, Ronald L. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 21, 1967. Contract W-7405-eng-48. 10p. (CONF-671026-12). Dep. CFSTI.

From 14th Nuclear Science Symposium, Los Angeles, Calif.

A system is described that can decrease the number of scalers required in a magnetostrictive spark-chamber readout system by a factor of four. Information from magnetostrictive sensors is impressed upon six magnetostrictive delay lines and digitized in sequence by six sets of scalers. In addition, an oscilloscope display is produced which correlates the delayed time-domain information with its digitized form. (auth)

6644 PULSE MAGNET FOR BUBBLE CHAMBER. Makar'in, V. K. (Inst. of Atomic Energy, Moscow). Prib. Tekh. Eksp., No. 4, 199-201(July-Aug. 1967). (In Russian).

The pulsed magnet, designed for work with the bubble chamber for high energy accelerator experiments was described. The pulsed magnetic field with intensity of 6 kOe in a volume of 20 l was produced with pulse lengths of ~2 msec. (tr-auth)

6645 EVALUATION OF THE ENERGY OF FAST PARTICLES BY IONIZATION MEASUREMENT IN NUCLEAR PHOTOEMULSIONS. Lepekhin, F. G.; Makarov, M. M.; Sarantsev, V. V. (Physical-Technical Inst., Leningrad). Prib. Tekh. Eksp., No. 4, 60-2(July-Aug. 1967). (In Russian).

A method for the evaluation of the energy of π mesons in the range from 30 to 150 MeV and of protons at 200 to 600 MeV by counting the stars on the tracks of these particles in the photoemulsion NIKFI BR-2, used without calibrated curves, was reported. It was shown that the evaluation obtained appears not displaced and the mean error of the energy evaluation is ~8% in counting of stars in 2.5 mm of track. (tr-auth)

6646 COMPLETE PROCESSING OF EXPERIMENTAL DATA, OBTAINED BY NUCLEAR EMULSIONS, USING A COMPUTER. Bukat, G. M.; Verkhoglyad, V. I.; Vershilova, N. M.; Lepekhin, F. G.; Makarov, M. M.; Sarantsev, V. V.; Tkach, L. N.; Shitikova, P. I. (Physical-Technical Inst., Leningrad). Prib. Tekh. Eksp., No. 4, 57-9(July-Aug. 1967). (In Russian).

A program for the complete processing of experimental data concerning the interaction of fast particles with the nucleons in nuclear photoemulsions was described. The measured magnitudes were obtained with a microscope with automatic derivation of the cipher information and were processed on a computer. The program was used for investigation of the $\pi N \rightarrow \pi\pi N$ reaction. (tr-auth)

6647 DETERMINATION OF THE COORDINATES OF PARTICLES BY MEANS OF A WIRE SPARK CHAMBER WITH FERRITE MEMORY. Asatiani, T. L.; Kovalenko, V. I.; Prokhorov, A. N.; Prokhorov, V. N. Prib. Tekh. Eksp., No. 4, 53-6(July-Aug. 1967). (In Russian).

Some characteristics of a wire spark chamber with dimensions of 1×1 m^2 with 1 mm spacing of the wire coils were reported. The possibility of realizing a feed regime for the chamber, during which the spark current passes through only one wire with a change in the amplitude of the high-current pulse from 3 to 8 kV, was shown. This makes it possible to code the information received in binary or binary-decimal code immediately at the electrode of the chamber. A method for the considerable simplification of the coding system of one coordinate by use of both electrodes of the chamber, appearing very effective during the preparation of a spark chamber of large dimensions, was proposed. The mean square error of the determination of the coordinates of the charged particles in the wire spark chamber does not exceed ±0.6 mm. (tr-auth)

6648 STREAMER CHAMBER FOR REGISTRATION OF THE STOPPING OF SLOW MESONS, CONTROLLED WITH A PROPORTIONAL COUNTER. Kulyukin, M. M.; Pontekorvo, D. B.; Falomkin, I. V.; Khazins, D. M.; Shcherbakov, Yu. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 4, 48-53(July-Aug. 1967). (In Russian).

An installation consisting of a streamer chamber of 400 mm and height 140 mm, filled with helium and a 1% methane admixture, for the registration of the stopping of slow mesons in the gas of the chamber was described. The construction of a multifilament proportional counter for separating the stopping of the slow mesons was treated and the possibility of combining the operation of these counters with streamer chambers in intense meson beams was shown. The construction of the chamber, controlled by two multifilament proportional counters, comprising one unit with the volume chamber, was described. Preliminary selection was done with scintillation counters with thin (1 mm) scintillators. The characteristics of the operation of the chamber with a cycle of 1.0 sec and with a time delay of several μsec in the charged particle beam was discussed. The subsequent μe tracks were photographed. The structure of the tracks and their dependence on the ionization, produced by the registration of the particles, were discussed. (tr-auth)

6649 LIQUID HYDROGEN BUBBLE CHAMBER WITH VOLUME OF 55 x 35 x 30 cm^3. Vetlitskii, I. A.; Guzhavin, V. M.; Kliger, G. K.; (and others) (Inst. of Experimental and Theoretical Physics, Moscow). Prib. Tekh. Eksp., No. 4, 43-8(July-Aug. 1967). (In Russian).

The construction and operational testing of a liquid hydrogen bubble chamber with effective volume of $55 \times 35 \times 30$ cm^3 were described. (tr-auth)

6650 PRINCIPLES AND APPLICATION OF THE IONIZATION CALORIMETER. Murzin, V. S. (Moscow State Univ.). pp 245-303 of Progress in Elementary Particle and Cosmic

Ray Physics. Vol. IX. Wilson, J. G.; Wouthuysen, S. A. (eds.). New York, John Wiley and Sons, Inc., 1967.

The discussion of the principles and application of the ionization calorimeter includes the main processes in the absorber of the ionization calorimeter, choice of parameters, control of the calorimeter, and the accuracy of the energy determination. The design and use of calorimeters are also discussed. (J.F.P.)

6651 CYLINDRICAL WIRE CHAMBER. Miller, D.; Hoffman, W. (Haverford Coll., Pa.). Nucl. Instrum. Methods, 57: 346-50(Dec. 1967).

A wire spark chamber was fabricated in a geometry natural for scattering and production processes and used to study proton-proton scattering. The construction of the chamber was possible as soon as new fabrication principles supplemented the magnetostrictive readout. Also discussed are a simple digitizer requiring only one scaler and a strategy for recognizing straight tracks. Particular care is taken to expose the few assumptions necessary to achieve a logically transparent system. (auth)

Radiation Dosimeters

Refer also to abstract 6554.

6652 (ORNL-4168, pp 183-230) RADIATION DOSIMETRY. Auxier, J. A. (Oak Ridge National Lab., Tenn.).

Current investigations in the area of radiation dosimetry are presented. Ichiban studies are discussed which include shielding studies associated with the Japanese bombing survivers, depth-dose calculations, and dosimetry related to Operation HENRE. Also discussed are spectrometry and dosimetry research, dosimetry applications, and HPRR and DOSAR Low-Energy Accelerator operations. (W.H.K.)

6653 (RT/PROT-(67)12) CARATTERISTICHE TECNICHE E MODALITA OPERATIVE DEL SERVIZIO DI DOSIMETRIA INDIVIDUALE DEL CNEN. (Prescribed Technique and Operating Procedure for Dosimeter Service at CNEN). Busuoli, G.; Cavallini, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). May 17, 1967. 20p. (In Italian). Dep.

The organization of the personnel dosimetry service is outlined. The characteristics of film badges for x rays, γ rays, slow neutrons plus γ rays, and fast neutrons are described. The procedure for the use of the various types of film badges are discussed. The cost of personnel monitoring is indicated. (J.S.R.)

6654 DEVELOPMENT OF THERMOLUMINESCENT DOSIMETERS AT TROMBAY. Nambi, K. S. V.; Sunta, C. M. (Atomic Energy Establishment, Trombay, India). pp 59-71 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14-18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

The design of radiation dosimeters using thermoluminescent materials is discussed. Properties of the CaF_2 and LiF thermoluminescent dosimeters tested are discussed. (W.H.K.)

6655 USE OF PHOTOMULTIPLIERS IN DOSIMETRY OF HIGH-POWER PULSED X RADIATION. Bekturganov, K.; Gumanskii, G. A. (Tashkent State Univ.). Prib. Tekh. Eksp., No. 4, 67-9(July-Aug. 1967). (In Russian).

The feasibility of registering pulsed x radiation with photomultiplier FEU-19A (antimony-cesium cathode) in the dose interval 0.15 to 400 R/sec is discussed. It is shown that the output current of the photomultiplier is directly proportional to radiation dose in the interval considered. The variation of the output current with hardness of the x rays is compared with stilbene in the x-ray tube voltage interval of 70 to 150 kV. (tr-auth)

6656 CORRECTION FACTORS TO THE CALIBRATION OF A SPHERICAL DOSIMETER UP TO 50 MeV NEUTRON ENERGY RADIOACTIVITY NEUTRON SOURCES. Heinzelmann, M. (Kernforschungsanlage, Juelich, Ger.). Atompraxis, 6: 2p.(1967). (In German).

A spherical dosimeter for neutrons up to 50 MeV is described. The dosimeter, however, is more sensitive in the 1.4 to 12 MeV range. The neutron energies of common (α,n) sources frequently used for calibration are in this region. Correction factors were determined with which it is possible to calibrate spherical dosimeters up to 50 MeV with ordinary (α,n) sources. (tr-auth)

6657 DETECTION OF LOW RADIATION DOSES OF PERSONNEL. Narrog, J. (Landesinstitut fuer Arbeitsschutz und Arbeitsmedizin, Karlsruhe, Ger.). Atompraxis, 7: 2p.(1967). (In German).

A study was made of the performance of routinely measured film dosimeters and glass dosimeters for use in the monitoring of personnel exposed to low radiation doses. It was shown that wearing the glass dosimeters for a long period of time, approximately 11 months, permits low radiation doses to be detected continuously, which cannot be done with monthly processed film dosimeters. (tr-auth)

6658 POSSIBLE UTILIZATION OF ACTIVATION DETECTORS AS HIGH-ENERGY PARTICLE DOSIMETERS. Sklavenitis, L. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Instrum. Methods, 58: 176-8(Jan. 1968). (In French).

Calculation of dose imparted to tissue by high-energy protons, from activity measurements on activation detectors, depends on knowledge of the proton energy spectrum. If there exists a proportionality factor between the excitation function of the nuclear reaction involved and the variation of the absorbed dose with proton energy, in the energy region under consideration, the dose becomes independent of the proton spectrum and is deduced from a simple activity measurement. Carbon, by its $^{12}C(p,pn)^{11}C$ reaction, satisfies precisely that condition for proton energies higher than 500 MeV and approximately for proton spectra extending to lower energies. (auth)

6659 CALORIMETER FOR HIGH-ENERGY ELECTRON BEAMS. Martin, F. W. (Univ., Mainz). Nucl. Instrum. Methods, 58: 73-6(Jan. 1968). (In German).

Construction details and experimental data are given for a total absorption calorimeter used for electron beams of several hundred MeV and for beam power up to 15 kW. In order to obtain high precision, precautions were taken to obtain very high heat insulation, specially by using a temperature controlled radiation shield. The heat loss of the 700 kg copper block corresponds to less than 10^{-3}°C/h. Due to design calculations and confirmed by preliminary comparison tests with other beam monitors we consider the absolute accuracy to be 1% or probably better. (auth)

6660 FADING IN THERMOLUMINESCENT LITHIUM FLUORIDE AFTER IRRADIATION WITH GAMMA-RAY DOSES UP TO 1000 RAD. Webb, G. A. M. (Berkeley Nuclear Labs., Gloucestershire, Eng.). Brit. J. Appl. Phys., 18: 1567-71(Nov. 1967).

In a previous paper the fading in thermoluminescent lithium fluoride after irradiation with low doses (0.5 rad) was examined. The present paper describes an extension of the work to higher gamma-ray doses, involving measurements of fading after 10 and 1000 rad for three types of phosphor. An accelerated fading technique was used, which was shown to agree with previous work at low doses. The results show that the fading is a monotonically decreased function of time and amounts to $7 \pm 2\%$ over 100 days for all phosphors up to doses of 1000 rad, with the exception of Con-Rad N at 1000 rad. The lower fading of this latter phosphor is attributed to the increase in sensitivity at doses greater than 100 rad being due mainly to the creation of deep traps, thereby reducing the proportion of shallow traps. Examination of glow curves supports this hypothesis. (auth)

6661 RADIATION-INDUCED BULK CONDUCTIVITY IN CADMIUM SULPHIDE AND APPLICATION TO THE DOSIMETRY OF IONIZING RADIATION. Koschel, K. W. (Cancer Inst., Melbourne). Aust. Phys., 4: 151-6(Sept. 1967).

The mechanism of ionizing radiation detection by semiconductors is discussed. The characteristics of two types of commercially available cadmium sulfide detectors are studied. Uses of cadmium sulfide detectors in radiotherapy dosimetry problems are described. (W.H.K.)

6662 THERMOLUMINESCENT RADIATION DOSIMETER FOR X-RAY AND GAMMA RAYS. Schayes, R. G. (to Mfg. Belge de Lampes et de Material Electroniques). Canadian Patent 760,529. June 6, 1967. Priority date Nov. 29, 1962, Belgium.

After exposure of the thermoluminescent material such as CaF_2 to radiation, heating arrangements are such that uniform temperature increase occurs both in the centre and at the edges. It is claimed that this uniform temperature control improves the accuracy. If direct heating from a coiled hot wire is used, the CaF_2 deposited as a film about 150 μm thick at the centre and 90 μm at the edges. If conduction heating is used the CaF_2 layer is of uniform thickness and the conducting layer is thicker in the centre. (F.S.A.)

Radiometric Instruments

Refer also to abstracts 6450, 6542, and 6833.

6663 (INR-808/XV/J) ROZPRASZANIE PROMIENI β. (β-Ray Scattering). Szepke, Ryszard (Institute of Nuclear Research, Warsaw (Poland)). 1967. 28p. (In Polish).

Angular distributions of back-scattered β-rays against localization of radiation source, incidence angles, collimation of radiation beam, detector burden by radiation, and hardness of reflection material has been experimentally investigated. An approach in comparison of β-reflection methods with a β-transmission method for paper thickness gaging was carried out. (auth)

6664 WIDE-RANGE RELIABLE RADIOISOTOPE IONIZATION MANOMETER. Khavkin, L. P. Prib. Tekh. Eksp., No. 4, 177-8(July-Aug. 1967). (In Russian).

A radioisotope ionization manometer, reliable in operation, was described. The manometer is capable of measuring the air pressure in the range from 10^{-5} to 760 torr. The reliability and wide range of measurement was attained by the use of ^{238}Pu as the active substance. (tr-auth)

6665 β-RAY AREAL-WEIGHT METER AND ITS APPLICATION FOR THE CONTROL OF A PAPER MACHINE. Moriya, Masatoshi (Yokogawa Electric Works Ltd., Japan). Kami Pa Gikyoshi, 21: 189-96(Apr. 1967). (In Japanese).

The application of a β-ray areal-weight meter for control of a paper machine is described, whereby the yield rate in the process of paper making is considerably increased. Compared to the usual method of weighing, e.g., at intervals of 30 min., the β-ray areal-weight meter continuously measures an average weight. The requirements for such an areal meter are: high insulation of the detection head, stability of ionization chamber, stability of the high resistor, stability of the geometry of radiation source and ionization chamber, drift due to the decay of the source intensity, problems of the variation of the temperature and pressure, problem of the variation of the moisture, error due to the static electricity, and so on. These difficulties involved in the application of a β-ray areal-thickness meter are explained, as well as the various components of the areal-weight control system. (NSA of Japan)

6666 SPATIAL RESOLUTION OF THE NEUTRON MOISTURE METER. Moerman, P.; De Boodt, M.; Mortier, P. pp 15-20 of STI/PUB-133.

It is shown that by using the Fermi-age theory for the slowing down and diffusion of neutrons, and the concept of the image source for evaluating the neutron density around a point source in a homogeneous medium near a boundary, it is possible to estimate the spatial resolution of the neutron moisture meter in accordance with the experimental determination of the sphere of influence. (auth)

6667 PROBLEMS IN GAUGING A NEUTRON PROBE: APPLICATIONS FOR THE DETERMINATION OF THE REAL EVAPOTRANSPIRATION OF CULTURES. Damagnez, J. pp 21-37 of STI/PUB-133. (In French).

The calibration of the neutron probe for soil moisture measurements in the field poses problems different from a classical calibration. The general conditions for the field use of the neutron probe are outlined. The calibration procedure used in the laboratory and in the field are given. The precision of the measurements and the counting statistics made with field use of the neutron probe were determined. The neutron probe as an example was then applied to measurements in the field of the actual evaporation-transpiration of maize cultures with two different irrigation treatments. The results showed that the neutron probe is well adapted to field measurements. (J.S.R.)

6668 PRINCIPAL CONSIDERATIONS AND LIMITING FACTORS CONCERNING THE APPLICATION OF DEPTH AND SURFACE EQUIPMENT FOR SOIL DENSITY MEASUREMENTS WITH GAMMA RAYS. Kuehn, W. pp 38-53 of STI/PUB-133.

Various characteristics essential for the design of gamma-ray density-measuring devices are studied by energy consideration and the introduction of the dose buildup factor. Quantitative relationships and experimental results concerning the effects of varying the gamma energy, source size and strength, and distance between source and detector are presented. The influence of the statistical fluctuations of the gauges is also discussed. (W.H.K.)

6669 BETA-RAY GAUGING TECHNIQUES FOR MEASURING LEAF-WATER-CONTENT CHANGES AND MOISTURE STATE OF PLANTS. Gardner, W. R. pp 54-6 of STI/PUB-133.

A short discussion of beta-ray gaging techniques for measuring the leaf water-content changes and moisture state of plants is presented. Interpretation of the beta measurements involves correlation of water content, water potential, and thickness of the leaf. (W.H.K.)

6670 OUTLOOK FOR DEVELOPING ISOTOPE AND RADIATION EQUIPMENT FOR MORE EFFICIENT USE IN THE PRODUCTION OF AGRICULTURAL CROPS. Booher, L. J. pp 57-9 of STI/PUB-133.

Various methods of measuring soil moisture are reviewed including soil sampling, resistance methods, and tensiometer methods. The disadvantages and limitations of these methods are pointed out, and the possibility of radiation techniques are discussed. (W.H.K.)

6671 VIEWPOINTS FOR THE DEVELOPMENT OF γ DENSITY MEASUREMENT DEVICES BY THE PENETRATION RADIATION METHOD. Loeber, C. (VEB Vakutronik WIB, Dresden). Isotopenpraxis, 3: 342-4(1967). (In German).

Some properties of the γ-penetration radiation method essential for the development and industrial application of γ density-measurement devices are described. The effect of these properties on the technical conception of the instruments is considered. Criteria for the selection and measurement of the activity of the radioisotope to be used and for the dimensioning and the construction of the measurement geometry were given as a function of the required measurement sensitivity and accuracy. (tr-auth)

Miscellaneous Instruments and Components

Refer also to abstracts 7820 and 7984.

6672 (BNWL-CC-1238L) ULTRASONIC ISOTOPE HEAT SOURCE TESTER. Dozer, B. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 21, 1967. Contract AT(45-1)-1830. 45p. Dep. CFSTI.

An ultrasonic tester was developed to test cylindrical isotope fuel elements for wall weld penetration and cracks, wall defects, and to measure the wall thickness. The tester consists of an electronic console and a mechanical device to rotate the sample. The electronic console is made up of electronic pulse processing equipment, a transducer location system, an X-Y recorder, a pulse time measurement system, motor controllers, and miscellaneous electronic equipment. The mechanical rotating device is a 14-inch metal lathe with the tail stock and tool post removed and the motor changed to reduce the lathe's minimum speed. A water tank was added to allow the chuck to rotate the piece being tested under water, and a transducer drive mechanism was added to the tool post carriage. In addition to this, various devices were incorporated to drive the readout circuitry. The tester was designed primarily to inspect end-cap welds on the fuel elements, but it will also measure wall thickness and locate cracks and defects. To do this, it utilizes a conventional ultrasonic pulse echo system. An oscilloscope is used to indicate the size and location of the ultrasonic echoes, while the wall thickness or wall defects and weld penetration may be plotted on an X-Y recorder. Relative transducer location is indicated in the longitudinal and transverse direction to the nearest thousandth of an inch. (auth)

6673 (DEG/SINR-68) MISE EN FORME TEMPORELLE POUR PHOTOMULTIPLICATEUR. (Construction of the Photomultiplier). Hesse, Michel (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Mar. 25, 1965. 10p. (In French). Dep.

The design of a circuit based on the principle of energy differentiation for a photomultiplier is described. The circuit permits the significant improvement of the resolution with respect to the method of the passage to zero. In the γ-γ coincidence of ^{60}Co for an entrance threshold of 1 V of the time-amplitude convertor, the resolution obtained is 0.44 n sec with a plastic scintillator and a PM 56 AVT photomultiplier. (tr-auth)

6674 (NP-17172) ETUDE ET REALISATION D'UN SEPARATEUR ELECTROMAGNETIQUE D'ISOTOPES A COEFFICIENT D'ENRICHISSEMENT ELEVE. (Development of an Electromagnetic Isotope Separator with High Enrichment Coefficient). Griboval, Paul (Grenoble Univ. (France). Faculte des Sciences). July 11, 1966. 24p. (In French). Dep.

Thesis.

A study is made of electromagnetic separation. The characteristics of a separator with high enrichment coefficient were defined. The separator has two identical magnetic analyzers with an inhomogeneous field index of 0.5, mean radius of curvature for trajectories of 50 cm, deviation angle of 170°, mass limit of 250, acceleration voltage of 50 kV, mean ion current at the collector of 1 mA and a high temperature ion source. The ionic trajectories and their aberrations were calculated. The construction of the separator is discussed. The operation of the source and the control of the separation were determined. In the test program the isotopes of Zn, Tb, Sn, Nd, and Pb were separated and the enrichment coefficients of each element at the first and second stage were

determined. The causes of contamination in the separation were investigated. (tr-auth)

6675 (NYO-2028-2, pp 159-69) INSTRUMENTATION FOR MOESSBAUER EFFECT EXPERIMENTS USING RADIOACTIVE SOURCES. Hershkowitz, N.; Gleason, T.; Lumpkin, L.; Loh, E. L. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics).

Various improvements to the instrumentation used for Moessbauer effect experiments using radioisotopes are described. These are improvements in the loudspeaker-based velocity transducer and speaker drive electronics, automatic liquid nitrogen control, and temperature control for gas cryostats. (B.G.D.)

6676 (ORNL-TM-1638(Pt.13)) NUCLEAR INSTRUMENT MODULE MAINTENANCE MANUAL. PART 13. MAGNET CONTROL AMPLIFIER, ORNL MODEL Q-2613. Anderson, J. L. (Oak Ridge National Lab., Tenn.). Nov. 2, 1967. Contract W-7405-eng-26. 15p. Dep. CFSTI.

The circuit, application, maintenance procedures, and acceptance tests for a magnet control amplifier are described. The amplifier is normally used to control the current to a scram latch magnet in a reactor safety system. When the bistate input signal is normal, the amplifier output is a regulated current adjustable from 0.3 to 2.2 amp. When the input switches to the abnormal state, the output current is switched to zero in less than 5 msec for a typical compatible magnet design. The control amplifier was designed specifically for the HFIR 3-coil, 2-out-of-3 coincidence magnet system, but may be used for single coil magnets as well. The circuit is constructed in a 3-unit module of the ORNL Modular Reactor Instrumentation series, Q-2600. (auth)

6677 (ORNL-TM-1989) SLIDING PULSE GENERATOR FOR TESTING MULTICHANNEL ANALYZERS. Millard, J. K. (Oak Ridge National Lab., Tenn.). Nov. 9, 1967. Contract W-7405-eng-26. 13p. Dep. CFSTI.

A sliding pulse generator was developed for checking the linearity of 4000-channel multichannel analyzers in the field. This instrument is packaged in the U. S. Nuclear Instrument Module (NIM) configuration. The amplitude of the output pulses, which occur at a rate of 250 per sec, vary directly with a generated, continuously running ramp having a slope of 66.7 mv/sec. The nonlinearity of this ramp is less than 1 part in 10^4. The output amplitude can be varied, by a selector knob on the front panel, between any two voltage levels from 0 to ±10 V. By means of a differentiating circuit, the ramp slope can be monitored on a chart recorder for long-term runs. (auth)

6678 (RISO-M-578) BERETNING OM ARBEJDET I ELEKTRONIKAFDELINGEN I TIDEN, 1. JANUAR TIL 31. MARTS 1967. (Quarterly Report on Electronics Research Covering the Period January 1–March 31, 1967). (Danish Atomic Energy Commission, Risoe, Research Establishment), June 1967. 26p. (In Danish and English). (R-9-67). Dep.

A progress report is presented on instrumentation. Topics discussed are data processing techniques, reactor instrumentation, industrial instrumentation, nuclear measurement techniques, analog computer techniques, and isotope measurement techniques. (J.S.R.)

6679 (RISO-M-643) BURN-OUT METER. Skanborg, P. Z. (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct. 1967. 7p. (R-22-67). Dep.

The so-called burn-out meter gives information about the cooling conditions at the place where the detector is placed. It is intended to be used in reactors to protect the fuel elements. The detector has to be placed at the outlet end of the fuel element. It consists of an electrically heated Pt-wire. (auth)

6680 (SNE-36) A SURVEY OF LEAK DETECTION METHODS FOR THE ON-LINE MONITORING OF BWR AND PWR PRIMARY LOOPS. Maxwell, W. A. (Southern Nuclear Engineering, Inc., Dunedin, Fla.). Oct. 1967. Contract AT(40-1)-3551. 43p. Dep. CFSTI.

Three major leak detection methods for the on-line monitoring of BWR and PWR primary coolant loops were investigated. These were detection methods based on radiation, sound, and humidity measurements. A summary is presented with comparisons and recommendations for the use of these various methods. (B.G.D.)

6681 (NRC-TT-1294) PHOTOELECTRIC NULL METHOD OF RECORDING RELATIVE FLUORESCENCE ENERGY SPECTRA. Koertum, G.; Bach, H. Translated by D. A. Sinclair (National Research Council of Canada), from Spectrochim. Acta, 21: 1117-25(1965). 14p. Dep. CFSTI. CAN.

Although in the measurement of absorption spectra, especially in the infrared, null methods are often used, these have hitherto been little used in fluorescence spectroscopy. This is due to the fact that the exciting radiation and emitted fluorescence lie in quite different spectral regions. For this reason Kortüm and Hess developed a suitable method. In this method, errors were eliminated which can arise from inexact proportionality between the strength of the exciting radiation and the photocurrent of the receiver, from reversible lag phenomena and changes in the spectral sensitivity of the photocathode, from long-term voltage variation and non-linear characteristics of the amplifier. This method has now been improved, and equipment has been developed which can be used for measurements over a wide temperature range, and for both solutions and solids. (auth)

6682 TIME-AMPLITUDE CONVERTER FOR THE MICROSECOND RANGE. Basiladze, S. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 4, 85-91 (July-Aug. 1967). (In Russian).

A time-amplitude converter operating in the microsecond range, developed for measurement of the lifetime of μ-atoms, was described. The converter works in the regions from 0 to 1 μsec and from 0 to 10 μsec. The resolution of the converter is no more than 1 nsec (in the 0 to 1 μsec range), the integral linearity is better than 1%, the long-lasting stability of the converter–amplitude analyzer system is no more than ±1%. (tr-auth)

6683 LINEAR GATING CIRCUIT FOR MICROSECOND PULSES. Rodionov, K. G.; Kun, Heng Yehn (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 4, 98-100(July-Aug. 1967). (In Russian).

A linear gating circuit with switches in series was described. A current circuit with transistors of different conductivities were used to open the gate. The circuit has a low pedestal <10 mV, broad linear range from 0 to 10 V, and wide gate, variable in the limits from 0.3 to 5 μsec. The dead time of the circuit is 2 μsec. The circuit can be used in antigating regime. (tr-auth)

6684 SUPERCONDUCTIVE STRIP DELAY LINE. Glebovich, G. V. (Gorky Polytechnic Inst., USSR). Prib. Tekh. Eksp., No. 4, 103-5(July-Aug. 1967). (In Russian).

The development of a superconductive strip delay line is reported. A wire helix (Nb and Zr alloy) 0.25 mm in diameter and 10.5 mm in length is placed in a 0.25-mm-deep helical groove in a quartz cylinder; the delay time of this line is 50 nsec. The surface of the quartz cylinder is coated successively with 0.25-mm layers of Teflon film and spiral lead tape 0.4 mm thick in such a manner as to locate the center of the tape over the wire. The lead tape serves as a ground plate for the asymmetric strip line. When the temperature approaches 4.2°K, the diameter of the quartz cylinder decreases only 0.11 mm while the other elements of the line contract to a much greater degree; this results in mechanical stability for the entire structure. The design makes it possible to achieve a given impedance to within a fraction of a percent. A pulse with a rise time of 0.47 nsec and an amplitude of 40 V was transmitted through this line. Measurements were carried out at room temperature (291°K), and at 4.2°K. During transmission of the pulse at room temperature, its shape was essentially distorted and the rise time increased 21 times. At 4.2°K, the pulse was transmitted without distortions. (ATD)

6685 TRANSISTORIZED NANOSECOND PULSE AMPLIFIER. Siz'min, A. M. (Scientific-Research Radiophysics Inst., Gorky, USSR). Prib. Tekh. Eksp., No. 4, 113-14(July-Aug. 1967). (In Russian).

A transistorized nanosecond pulse amplifier consisting of one or two cascaded sections is described. One section consists of cascade amplifier and an emitter follower. For matching purposes, 75-ohm resistors are connected at the amplifier input and output. The upper cutoff frequency for a single-section and a two-section amplifier is 60 MHz and 38 MHz, respectively; the lower cutoff frequency for both amplifiers is about 5 kHz. The gain of single- and two-section amplifiers is 10 and 100, respectively. With an input pulse rise time of 13.1 nsec, the measured output pulse rise time of the one-section amplifier was 14.4 nsec. (ATD)

6686 PULSE GENERATOR. Lazakov, V. N. (Inst. of Physics of Semiconductors, Novosibirsk, USSR). Prib. Tekh. Eksp., No. 4, 115-16(July-Aug. 1967). (In Russian).

The block diagram of a pulse generator, developed on the basis of the signal generator GS-23, was described and the modulator circuit was given. The output power on the average is 130 W for the frequency range from 5 to 28 MHz. The output power is 14 W for the range from 28 to 138 MHz. The pulse duration can be controlled from 1.5 to 1000 μsec. (tr-auth)

6687 FREQUENCY STABILIZATION OF A MILLIMETER BAND KLYSTRON WITH AN OPEN RESONATOR. Shamfarov, Ya. L. (Inst. of Radiophysics and Electronics, Kharkov). Prib. Tekh. Eksp., No. 4, 119-21(July-Aug. 1967). (In Russian).

A frequency stabilization method for a millimeter band reflex

klystron is described. The technique uses a waveguide positive feedback that includes an open feed-through resonator, which in effect changes the klystron from a regenerative amplifier into a very stable oscillator. (ATD)

6688 NUCLEAR MAGNETOMETER. Grishchenko, E. M. (Physical-Technical Inst., Kharkov). Prib. Tekh. Eksp., No. 4, 131-3(July-Aug. 1967). (In Russian).

The transistorized nuclear magnetometer with remote control, permitting the measurement of the intensity of magnetic fields with heterogeneities up to 15 Oe in the range from 1.6 to 9.6 kV, was described. The magnetometer consists of a load circuit, placed directly on the magnet poles, and a remote-control circuit. (tr-auth)

6689 THERMOSTATIC SYSTEM FOR THE EVAPORATION OF SAMPLES OF SUBSTANCES TO BE INVESTIGATED IN THE ION SOURCE OF THE MASS SPECTROMETER MKH-1303. Zyakun, A. M. (Inst. of Chemistry of Natural Compounds, Moscow). Prib. Tekh. Eksp., No. 4, 162-5(July-Aug. 1967). (In Russian).

The construction of the lap joint system for the mass spectrometer MKH-1303, used to evaporate the substances to be studied in the vicinity of the ionization range of the ion source, was described. The system was provided with a thermostatic liquid heater, stabilizing selected temperature in the interval from 0 to 250°C with a precision of ±0.5°. (tr-auth)

6690 MASS SPECTROMETER FOR THE MEASUREMENT OF THE ISOTOPE RATIO OF MICROQUANTITIES OF NOBLE GASES. Teplykh, V. F.; Petrzhak, K. A.; Pan'yan, M. G. (Leningrad Technological Inst.). ; Prib. Tekh. Eksp., No. 4, 165-7(July-Aug. 1967). (In Russian).

The reconstruction of the mass spectrometer M113-05, in which the pulse method was used for the recording of ions of two beams with one collector, was described. The secondary electron multiplier was used as an ion detector. The ratio of the diffusion of the isotopes ^{134}Xe and ^{136}Xe in samples containing 10^{-9} to 10^{-8} cm^3 of the analyzed gas was measured with a precision of 3% in this spectrometer operating in the dynamic regime. (tr-auth)

6691 NANOSECOND COINCIDENCE CIRCUIT FOR MULTICHANNEL RECORDING. Suvorov, V. M.; Shchetkovskii, A. I. (Physical-Technical Inst., Leningrad). Prib. Tekh. Eksp., No. 4, 79-81(July-Aug. 1967). (In Russian).

A multichannel coincidence circuit with time resolution in the nanosecond range is described. A schematic shows one of three is determined by transistor response. In the circuit shown, the minimum resolution is 3.8 nsec when delay line length is 0.3 m. Two figures are presented which show the coincidence interval as a function of input signal level, and the response characteristics of coincident and anticoincident portions. A p-n-p triode such as an IT308, with a frequency response up to 1 GHz, is suggested for the input stage; for the emitter follower and output stages, n-p-n triodes of the same characteristics are recommended. Tunnel diode TD-1 is a type 3I201B, rated at 5 mamp peak. The design is applicable to recording of random, short duration events such as in radiation studies. (ATD)

6692 A LIQUID HELIUM, TIME OF FLIGHT NEUTRON POLARIMETER WITH A SPIN ROTATING SOLENOID. Katori, Kenji; Kamitsubo, Hiromichi (Tokyo Univ.). Technical Report of ISSP (Inst. for Solid State Physics), Series A, No. 256, 1-49(June 1967).

A liquid helium time-of-flight polarimeter with a spin rotating solenoid has been developed to measure neutron polarization for the energies as low as 800 keV. Energy selection is accomplished by time-of-flight techniques and accuracy of polarization measurement is improved by a spin rotating solenoid. Measurements of the neutron polarization for the $^7Li(p,n_0)^7Be$ and $^{12}C(d,n_0)^{13}N$ reactions were made for the proton and deuteron energies at 2.8 MeV and 1.62 MeV at laboratory angles of 52° and 70°, respectively. The polarization of the neutron for the $^{12}C(n,d_0)^{13}N$ reaction is $-(33.2 \pm 2.3)\%$. (auth)

6693 ON THE AUTOFLUOROSCOPE: A MEDICAL ISOTOPE-IMAGE DEVICE. Yamamoto, Yuji (Kobe Ind. Corp., Japan). Kobe Kogyo Giho, No. 32, 24-9(Nov. 1966). (In Japanese).

The autofluoroscope has a large-area high-sensitivity detector capable of covering and thus measuring simultaneously the whole of a subject organ. Consequently, it can give the radioisotope distribution images in a very short period of time. The advantages thus obtained are the quantitative recording of radioisotope distributions in the body (or organ), the dynamic investigation of changes in the distribution, as well as the small amounts or short half-lives of radioisotopes used. A description is made of this autofluoroscope, with emphasis on the one first constructed in Japan and delivered to Kyoto University, in the following sections: the principles underlying the autofluoroscope; the detector; the instruments; and its applications including diagnosis of tumors, measurement of dynamic phenomena, and quantitative analysis of the measured results. (NSA of Japan)

6694 LINEAR GATE. Schuster, H. J. (Physikalisch-Technische Bundesanstalt, Brunswick). Nucl. Instrum. Methods, 58: 179-80(Jan. 1968). (In German).

Specifications of the linear gate: deviation from integral linearity less than 0.1% for pulses up to 10 V, a rise time of 5 ns at the input is increased at the output to 5.5 ns for the pulseheight below 1 V, to 50 ns for a pulseheight of 10 V, pedestal adjustable to zero feedtrough (gate closed) 10 mV for a 10 V pulse. (auth)

6695 ACCURATE PULSE-SHAPE DISCRIMINATOR FOR A WIDE RANGE OF ENERGIES. Sabbah, B.; Suhami, A. (Technion-Israel Inst. of Tech., Haifa). Nucl. Instrum. Methods, 58: 102-10(Jan. 1968).

For pulse shape discrimination the charge comparison method and the zero-cross timing method are analyzed, and the superiority of the former for low energies is shown. A fast accurate circuit for pulse shape discrimination is described, and the results obtained with the liquid scintillator NE213 are presented. Its γ rejection ratio remains better than 1000:1 for neutron energies down to 50 keV. (auth)

6696 NUMERICAL DIFFRACTION CORRECTION VALUES FOR TWO-BEAM RADIOINTERFEROMETER WITH ONE CLOSED ARM. Simkin, G. S.; Gerasimova, S. D.; Sikora, S. V. Izmer. Tekh., No. 8, 86-7(Aug. 1967). (In Russian).

Tables are given for the numerical values of the diffraction corrections for the dimensionless parameter A from 0.40 to 0.01 through 0.01. The parameter A is defined by the equation $A = \pi a^2/(\lambda Z)$, where a is the half-width of the aperture, λ is the wavelength, and Z is the distance from the aperture to the mirror. This can be used for two-beam radiointerferometer, emitting any wavelength under the condition that the apertures of the mouth and mirror are equal and represents the quadrate with the side 2a. (tr-auth)

6697 DESIGN OF A SAFETY SYSTEM FOR X-RAY GENERATORS. Sutherland, H. H. (Univ. of Hull, Eng.). J. Sci. Instrum., 44: 1039-40(Dec. 1967).

A safety system is described which eliminates accidental irradiation of the operator of an x-ray generator. The generator is enclosed and mechanical window shutters are operated by remote control. (auth)

6698 NEW HIGH PRESSURE IONIZATION GAUGE. Cleaver, J. S. (Edwards High Vacuum International Ltd., Crawley, Eng.). J. Sci. Instrum., 44: 969-72(Dec. 1967).

A high-pressure ionization gage is described having a novel electrode system of rugged construction. The electrodes consist of two parallel electron collector plates and two parallel ion collector plates mounted at right angles to each other with a filament running axially down the center. The filament consists of a platinum-10% rhodium wire with an yttrium oxide coating, allowing the gage to operate in reactive gases, such as atmospheric air, up to a pressure of 5 torr. Evaluation of the gage characteristics enabled the optimum operating conditions to be achieved. The gage sensitivity is equal to 0.11 $torr^{-1}$ for air, and is constant within the pressure range 1 torr to 50 μtorr providing the electron accelerating potential is not greater than 42 eV. The gage can be usefully employed in the pressure range required for applications such as cathodic sputtering, vacuum melting, gas discharge studies, and as a secondary calibration standard. (auth)

6699 EVALUATION OF FOCUSED COLLIMATOR PERFORMANCE. II. DIGITAL RECORDING OF LINE-SOURCE RESPONSE. Hine, Gerald J. (International Atomic Energy Agency, Vienna). Int. J. Appl. Radiat. Isotop., 18: 815-23 (Dec. 1967).

A scheme was developed for presenting the geometrical specifications of focused collimators and their physical properties for scanning extended sources. The performance of a collimator is described by its plane-source sensitivity (which is nearly independent of the source-to-collimator distance), its central axis depth response, and its spatial resolution as a function of depth for a given γ-ray energy. All three parameters are derived from a set of line-source measurements in air. An analysis of the line-source response determines the septum penetration for the selected γ-ray energy. For sources in an absorbing medium, the depth response of the collimator must be modified by an experimentally determined γ-ray attenuation coefficient while the resolution of the collimator remains unchanged. (auth)

6700 EXPERIMENTAL STUDY OF THE MAGNETIC PRISM OF AN ELECTROMAGNETIC ISOTOPE SEPARATOR. Camplan, J.; Meunier, R. (CNRS, Orsay, France). Nucl. Instrum. Methods, 57: 252-6(Dec. 1967).

Two experimental methods are described. One, using a floating wire, leads to the knowledge of the optical axis of the prism. The other, using an ion beam, leads to the determination of correcting profiles which, when put on the entrance face of the prism, reduce the image width to an acceptable value. (auth)

6701 MICROWAVE AND OPTICAL GENERATION AMPLIFICATION. 6th International Conference, Cambridge, September 1966. IEE Conference Publication 27. London, The Institution of Electrical Engineers, 1967. 540p. (CONF-660932).

Separate abstracts were prepared for 13 of the included articles. (M.O.W.)

For abstracts of individual papers see: 6702–6706, 7140, 7286–7291, and 7578.

6702 A 20 kW CW KLYSTRON AMPLIFIER AT 18 GHz. James, Bill G. (Varian Associates, Palo Alto, Calif.). pp 1-5 of Microwave and Optical Generation Amplification. IEE Conference Publication 27. London, The Institution of Electrical Engineers, 1967.

From 6th International Conference on Microwave, Optical Generation, and Amplification, Cambridge, Eng., Sept. 12–16, 1966. See CONF-660932.

The design and performance of a 20-kW CW klystron amplifier operating at 18 GHz are discussed. Topics included are beam design, tube description, rf cavities, and tube performance. The klystron was designed specifically to be used in a "cyclotron resonance" plasma fusion experiment. (W.H.K.)

6703 EXPERIMENTS ON A PLASMA BACKWARD-WAVE OSCILLATOR. Beck, A. H.; Gregory, B. C.; Mourier, G. (CSF-CEPEC, Orsay, France). pp 480-4 of Microwave and Optical Generation Amplification. IEE Conference Publication 27. London, The Institution of Electrical Engineers, 1967.

From 6th International Conference on Microwave, Optical Generation, and Amplification, Cambridge, Eng., Sept. 12–16, 1966. See CONF-660932.

A beam-plasma backward wave oscillator was described, yielding oscillation powers of over 1 watt. At present the efficiency is very low and the oscillations exhibit frequency spectra of over 100 MHz in width. However, there seems to be little doubt that efficiency and power output can be improved by technological changes of a minor nature. (auth)

6704 STIMULATED CYCLOTRON ECHO RADIATION FROM PLASMAS. Crawford, F. W. (Stanford Univ., Calif.); Harp, R. S.; Ikegami, H. pp 509-14 of Microwave and Optical Generation Amplification. IEE Conference Publication 27. London, The Institution of Electrical Engineers, 1967.

From 6th International Conference on Microwave, Optical Generation, and Amplification, Cambridge, Eng., Sept. 12–16, 1966. See CONF-660932.

Experimental results of echoes are compared with theoretical ones. (M.O.W.)

6705 COUPLER FOR LAUNCHING ELECTROMAGNETIC WAVES ON PLASMA COLUMNS. Singh, Amarjit; Gupta, K. C. (Central Electronics Engineering Research Inst., Pilani-Rajasthan, India). pp 520-4 of Microwave and Optical Generation Amplification. IEE Conference Publication 27. London, The Institution of Electrical Engineers, 1967.

From 6th International Conference on Microwave, Optical Generation, and Amplification, Cambridge, Eng., Sept. 12–16, 1966. See CONF-660932.

Surface-wave type of coupling to a plasma column is described. (M.O.W.)

6706 GAP EXCITATION OF ELECTRON BEAM–PLASMA SYSTEMS. Narayan, S. Yegna (Cornell Univ., Ithaca, N. Y.). pp 525-9 of Microwave and Optical Generation Amplification. IEE Conference Publication 27. London, The Institution of Electrical Engineers, 1967.

From 6th International Conference on Microwave, Optical Generation, and Amplification, Cambridge, Eng., Sept. 12–16, 1966. See CONF-660932.

The theory of gap excitation of a waveguide loaded with a plasma has been developed. The theory is a linearized small-signal analysis under the quasi-static approximation. (M.O.W.)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 7361.

6707 (LYCEN-6756) COMPORTEMENT DE MONOCRISTAUX DE SILICIUM ET DE JONCTIONS A BARRIERE DE SURFACE SOUS IRRADIATION AUX NEUTRONS RAPIDES. (Behavior of Silicon Single Crystals and Surface-Barrier Junctions Under Fast-Neutron Irradiation). Drain, Daniel (Lyon Univ. (France). Institut de Physique Nucleaire). July 1967. 51p. (In French). Dep.

Thesis.

Two methods for studying the effects of radiation on semiconductors, particularly of fast neutrons on n-type silicon, were used: one consists of observing the variations of the electrical properties of the semiconductor due to the appearance of faults in the irradiated crystal and the other is the study of the modifications of the properties of p-n junctions, which makes it also possible to define the limits of utilization of junction detectors when they are exposed to fast neutron irradiation. The process of the creation of faults in semiconductors is first reviewed. The measurements made of the resistivity and Hall effect making it possible to obtain the physical parameters characterizing the monocrystal and their modifications under irradiation are described. The evolution of the electrical properties of p-n junction detector was followed. (J.S.R.)

6708 RANGE–ENERGY RELATION FOR LOW ENERGY PROTONS IN Si AND Ge. Marcinkowski, A. (Inst. of Nuclear Research, Warsaw); Rzewuski, H.; Werner, Z. Nucl. Instrum. Methods, 57: 338-40(Dec. 1967).

The range-energy relations for protons of energy between 0.8 and 2.0 MeV in Si and Ge were determined. For the measurement of the proton energy a 100 channel pulse-height analyzer and silicon semiconductor detector were used. The range energy relations for Si and Ge were assumed to be of the form $R(\mu m) = aE^x(MeV)$ and the parameters a and x were calculated using a least-squares fit. The following analytical expressions in the measured energy range were obtained: $R_{Si}(\mu m) = 16.41\ E^{1.64}(MeV)$ and $R_{Ge}(\mu m) = 7.52\ E^{2.05}(MeV)$. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 6567, 6772, 6774, 6795, 6811, 6817, 6830, 6832, 6837, 6869, 6877, 6895, 7935, and 7940.

6709 (ACRH–1000-21) INHIBITION OF THE GROWTH OF THE MORRIS HEPATOMA (5123) IN BUFFALO RATS USING A MIXTURE OF PERTUSSIS VACCINE AND IRRADIATED TUMOR. Wissler, Robert W.; Craft, Karen; Kesden, David; Polisky, Barry; Dzoga, Katti (Argonne Cancer Research Hospital, Chicago, Ill.). June 1967. Contract AT(11-1)-69. 19p. (CONF-670642-1). Dep. CFSTI.

From 1st International Conference on Organ Transplantation and Bone Marrow, Paris, France.

Experiments with rats indicated a consistent immunological effect when pertussis vaccine plus hepatoma were given as a combined treatment either after the development of a well-established tumor or prior to transplantation of the tumor. Injection of normal liver or normal liver plus pertussis vaccine did not produce a similar effect. The same phenomena were not apparent when Freund's adjuvant was substituted for pertussis vaccine. The value of adding hyaluronidase to the immunizing mixture was not demonstrated. Irradiation of the hepatoma or liver homogenate did not seem to interfere with the immunizing characteristics of the tissue antigen. Histological observations indicated that the tumors from animals treated with the mixture of hepatoma and pertussis frequently showed cellular reactions at the border of the tumor. The spleens of animals treated with hepatoma plus pertussis or with pertussis vaccine alone showed hyperplasia. (H.L.W.)

6710 (ACRH–1000-26) BIOLOGICAL DEPTH DOSE STUDIES IN ELECTRON BEAM THERAPY: EFFECTS ON ANAGEN MOUSE HAIRS. Lanzl, Lawrence H.; Malkinson, Frederick D. (Chicago Univ., Ill. Argonne Cancer Research Hospital, Chicago, Ill.). July 1967. Contract AT(11-1)-69. 4p. (CONF-670719-3). Dep. CFSTI.

From 13th International Congress of Dermatology, Munich, Germany.

Hairs were plucked from both flanks of mice and 24 days later they were replucked. Twelve days later the right flank was exposed to electrons. The body thickness of 2.5 cm separated entry (right flank) and exit (left flank) treatment portals. Intravenous injections of ^{3}H-DL-serine were given 48 hrs later. On the 24th day hairs from both flanks were plucked. Hair samples were weighed and placed in a combustion apparatus in the presence of oxygen. Radioactivity was assayed in a liquid scintillation spectrometer. Low-dose exposure (300 rads) depressed serine uptake in hair almost equally at entry and exit portals. At moderate doses of 500 to 600 rads, reduced incorporation of serine at the beam entry site was further lowered by 15% at the exit portal. (H.L.W.)

6711 (BARC–287) BIOCHEMICAL EFFECTS OF IONISING RADIATIONS. Sreenivasan, A. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 26p. Dep.

Biochemical effects of ionizing radiations are reviewed. Lethal radiation dose invarious organisms and the protection afforded by various organs against lethality of whole-body irradiation are discussed. The roles of lysosomes, microsomes, and mitochondria in manifestation of radioinduced cellular damage are considered; effects of radiation on cell nuclei are identified. Studies were also conducted on the repair of radiation damage to DNA, and on effects of radiation on protein metabolism, isolated cells, and cell colonies. (H.L.W.)

6712 (COO–1172-7) THE EFFECT OF IRRADIATION ON THE LOCALIZING RESPONSE (TO ANTIGEN) IN IMMUNITY. Progress Report, May 15, 1966–May 15, 1967. Kahn, Reuben L. (Michigan Univ., Ann Arbor). May 15, 1967. Contract AT-(11-1)-1172. 31p. Dep. CFSTI.

X RADIATION—effects on antitoxin-localizing ability in tissue of rabbits, effects of dose on; effects on localization of injected protein in tissues of rabbits, effects of inflammation on; effects on antitoxin-localizing response in rabbits, effects of diurnal rhythm on; effects on localization of radioiodine-labeled serum albumin in rabbits; effects on leucocyte count in rabbits, focal (E.R.B.)

6713 (COO–1455-2) [PROGRESS REPORT ON RADIOBIOLOGY]. Final Report. Auerbach, Robert (Wisconsin Univ., Madison). Nov. 9, 1967. Contract AT(11-1)-1455. 1p. DTIE.

In vitro studies involving organ cultures were used to describe the interactions between irradiated spleen, normal bone marrow, and thymus. More complex interactions were analyzed by using urethan in conjunction with x radiation. A suitable assay system for immune responses in vitro was developed. The system was used to study x ray effects on the spleen, and the role of the thymus in subsequent regeneration of immune capacity. Studies of the effects of thymic extracts on regeneration of spleen following x radiation did not lead to clear demonstration of any thymic extract activity. The in vitro assay procedures were analyzed critically with an effort to improve the quantification of the immune response obtained. (auth)

6714 (LF–35) LONG TERM WHOLE-BODY RETENTION AFTER HIGH LEVEL ^{137}Cs ADMINISTRATION TO RATS. Technical Progress Report. Thomas, Robert G.; Thomas, Randi Lie (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex. Dept. of Radiobiology). Sept. 1967. Contract AT(29-2)-1013. 12p. Dep. CFSTI

A long-term component of ^{137}Cs whole-body retention in rats was found. The early retention kinetics, through approximately 120 days following intraperitoneal injection, show similarities to previously reported data from other investigators. However, use of higher levels of injected isotope has enabled measurement of body burdens for periods approaching one year and has resulted in discovery of a component of loss that has a half-life of 102 days. This retention component represents only 1.5×10^{-4} of the initial body burden and would not contribute significantly to the radiation dosage. It does, however, represent a fraction of whole-body retention that was not reported for rodents and that may be present in other species. Certain broad physiological parameters such as age, body weight, and sex are discussed relative to the observed retention kinetics. (auth)

6715 (NYO–2514-9) STUDIES ON BIOLUMINESCENCE AND ENERGY TRANSFER MECHANISMS. McElroy, W. D. (Johns Hopkins Univ., Baltimore, Md.). Nov. 15, 1967. Contract AT(30-1)-2514. 13p. Dep. CFSTI.

Progress is reported on studies on identification of intermediates and products of the light reaction in firefly luminescence. Experiments were conducted to determine the fate of the substrate LH_2, the nature of the emitting species, and the function of the enzyme luciferase. Dehydroluciferin was synthesized, and peptides containing this substance were isolated and purified. (H.L.W.)

6716 (ORO–284-10) RELATION OF ENDOGENOUS THYROCALCITONIN SECRETION TO PLASMA CALCIUM LEVELS. Talmage, Roy V.; Klein, D. C. (Rice Univ., Houston, Tex.). July 1, 1967. Contract AT(40-1)-284. 5p. (CONF-670717-1). Dep. CFSTI.

From Symposium on Thyrocalcitonin and C Cells, London, England.

Experiments with rats demonstrated that thyrocalcitonin was essential for overall calcium homeostasis. Rats were thyroidectomized and given parathyroid transplants; calcium was administered to experimental and control rats by the peritoneal lavage technique. Serum calcium levels were determined from blood samples obtained by heart puncture. Differences between the control and thyroidectomized groups were apparent only during the recovery stage. In other experiments, ^{85}Sr was injected into thyroparathyroidectomized and parathyroidectomized rats. The amount of radioactivity increased in the thyroparathyroidectomized group with time, while that of the parathyroidectomized group decreased with time. (H.L.W.)

6717 (UCD–472-210) X-RAY EMISSION QUANTITATION OF TRACE ELEMENTS IN BIOMEDICAL RESEARCH. Goldman, Marvin; Beckman, E. D. (California Univ., Davis. Radiobiology Lab.). [1967]. Contract AT(04-3)-472. 26p. (CONF-670518-3). Dep. CFSTI.

From 18th Annual Mid-America Symposium on Spectroscopy, Chicago, Ill.

Determination of trace element concentrations in biologic materials is often limited by matrix effects and interelement interferences. X-ray spectrometry can provide rapid, nondestructive quantitation of trace metals at the ppM level. Derivation of empirical absorption coefficients utilizing standardized specimen preparation can optimize precision and accuracy of determinations. The specimen is used as an absorber of the characteristic wave length of the element to be quantitated and provides an index of excitation efficiency essential to the quantitation of emission intensity. Food and tissue specimens were analyzed and the results compared to those obtained by other analytical methods. Calibration techniques using internal

and reference standards are illustrated. Determinations of Ca, Sr, Zn, Tl, Se, Fe, I, and Ti were applied to the study of specific problems in metabolic, geriatric and cancer research. (auth)

6718 (UCRL-17771) TRACER KINETIC STUDIES OF THE DYNAMICS OF THE MICROCIRCULATION IN PERIPHERAL VASCULAR BEDS. Hippensteele, J. Robert (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 29, 1967. Contract W-7405-eng-48. 89p. Dep. CFSTI.

Thesis.

A theory that utilizes tracer kinetics was developed and applied to the quantitative computation of relative changes in the extravascular mixing volume for an exchangeable substance injected into the arterial blood supply of a peripheral vascular bed. This mixing volume was shown to increase by as large a factor as 2.9 in the hind limb of the dog during an adrenalin infusion. The experiments performed involved an intra-arterial injection of a mixture of an exchangeable and a nonexchangeable substance labeled with ^{198}Au, ^{14}C, and ^{24}Na and subsequent monitoring of the tissue supplied by the artery, and simultaneous sampling of the venous blood leaving the tissue. The spatially inhomogenous nature of the blood perfusion (i.e., the existence of different perfusion rates in different regions) of skeletal muscle tissue was confirmed in these studies. That a large fraction of resting skeletal muscle tissue is not nutritively perfused is shown by the large increase in the extravascular mixing volume which becomes available to certain tracer substances during an adrenalin infusion. This suggests that a feedback mechanism controls the proportionate time spent in stasis and in flow by the blood in capillaries, thereby regulating the number of capillaries that are open at any instant in time. Changes in the ratio of the injected substances in early samples of venous blood from the hind limb of the dog support the proposition that effective shunts exist in skeletal muscle vascular beds. Data are presented which indicate that this effective shunting of blood through the vascular bed could be, to some extent, a result of partial diffusion limitation on the clearance of the exchangeable substance from the plasma. All the data reported in these experiments are consistent with the concept that the effective shunts could include both anatomical shunts and such shunting mechanisms as partial diffusion limitation of the clearance of the test substance injected. (auth)

6719 (UCSF-10P2-33) THYMIDINE METABOLISM AND H^3 THYMIDINE SUICIDE IN MAMMALIAN CELLS. Cleaver, J. E. (California Univ., San Francisco. Medical Center). Sept. 2, 1967. Contract AT(11-1)-Gen-10. 21p. (CONF-671036-1). Dep. CFSTI.

From Meeting on Biological Effects of Transmutation and Decay of Incorporated Isotopes, Vienna, Austria.

The design of tissue culture experiments with tritium-labeled thymidine (TdR) must take into account the intracellular pool size of thymine nucleotides, approximately 2×10^6 to 5×10^7 molecules/cell, the range of extracellular TdR concentrations over which trace and flooding conditions prevail, and the depletion of TdR from the medium. Relatively simple labelling conditions are obtained with high TdR concentrations such that all the DNA thymine originates from the exogenous supply. The thymine in newly synthesized DNA then has the same specific activity as exogenous TdR. From preliminary experiments with HeLa cells, ^3H decays have little effect on DNA synthesis until cells have passed through several cell cycles. After two cell cycles a marked reduction occurs in DNA synthesis in cells grown in tritium-labeled thymidine (TdR) as compared to ^{14}C-labeled thymidine (TdR). Suicide experiments with mouse lymphoma cells demonstrate that the killing efficiency per ^3H decay depends on the location of the ^3H atoms. Survival curves for cell killing from decays in one DNA strand, nuclear RNA, whole cell RNA, and whole cell RNA plus protein are all exponential with no shoulder. The survival curve for ^3H decays in both DNA strands is similar to that for single strand label at low numbers of decays but is steeper above 400 decays per cell. The D_{37} doses, in decays per cell, are: 80 (double strand DNA), 175 (single strand DNA), 650 (nuclear RNA), 1000 (whole cell RNA), and 1400 (whole cell pool plus protein). Although these results demonstrate that the site of ^3H decays is important and that decays are most efficient when they occur in DNA, a clear distinction between transmutation and β particle irradiation cannot be made. (auth)

6720 (TT-1283) BIOLOGICAL EFFECTS OF RARE, DISPERSED AND OTHER METALS AND THEIR COMPOUNDS USED IN INDUSTRY. TELLURIUM. Sandratskaya, S. E. Translated by H. R. Hayes (National Research Council of Canada, Ottawa, Ont.), from Toksikol. Redk. Metal., Medgiz, Moscow, 117-35(1963). 16p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The chemical and toxic properties of tellurium are reviewed briefly. Experiments were carried out to determine the comparative toxicity of tellurium and its dioxides in various doses, and the principal critical points of the action of these substances. Other experiments on the effects of inhalation of various aerosols of tellurium and its dioxide were conducted. Aerosols used were condensation aerosols composed of finely divided tellurium dioxide in concentrations of 0.01 and 0.05 mg/l and disintegration aerosols of polydisperse tellurium and tellurium dioxide powders in a concentration of 0.1 mg/l. Tellurium-127 was used to determine metabolism of tellurium in various organs and tissues as well as its distribution in constituents of the blood. Assimilation was greatest in the blood and kidneys and least in the skeletal muscles and brain. The results were used in evaluation of the permissible tellurium content of the air. (H.L.W.)

6721 (UCRL-Trans-10099) STUDIES ON THE CONTENT AND DISTRIBUTION OF ZINC IN THE PANCREAS. Shevchuk, I. A. Translated by S. Silcock for Univ. of California, Lawrence Radiation Lab., Livermore, from Mikroelem. Sel. Khoz. Med., Ukr. Nauch.-Issled. Inst. Fiziol. Rast. Akad. Nauk Ukr. SSR, Mater. 4-go Vses. Soveshch., Kiev, 1962, 669-72(1963). 10p. (CONF-620705-1). Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

In experiments with dogs, rabbits, guinea pigs, and man it was demonstrated that zinc is concentrated primarily in the cytoplasm of the α- and β-cells of the islets of Langerhans and that it also occurs in the zymogen zone of acinar cell cytoplasm. The highest zinc content in human pancreas is found in children during the first months of life, when the number of the islets of Langerhans is also at its height. Under the influence of factors that reduce the functional activity of the islet apparatus, the pancreatic content is decreased and vice versa. Zinc is involved not only in insulin formation, but evidently also in the production of glucagon, and possibly also of lipocaine. The rise in the pancreatic zinc content under the influence of adrenaline, and its diminution under the influence of thyroidin, indicates the close connection and interdependence between the pancreas and other endocrine glands. (H.L.W.)

6722 KINETICS IN THE LIVER OF INORGANIC ^{131}I INJECTED INTO THE RECTUM AND ITS CLINICAL APPLICATION. Takeda, Tsukune (Kurume Univ., Japan). Nippon Shokakibyo Gakkai Zasshi, 63: 58-67(Jan. 1966). (In Japanese).

Inorganic ^{131}I was injected into the rectum of dogs and rabbits, and the metabolism of ^{131}I that reached the liver through the portal vein was studied. The results were as follows; ^{131}I is rapidly transferred to the liver through the portal vein (the curve of external counting over the liver reaches a plateau within about five min.), part of it is actively disposed of and excreted into the bile after being taken into the liver cells, and the remainder comes out into the systemic circulation, passing the liver without stopping or being released by the liver cells. As ^{131}I was hastily absorbed by the rectum, it accumulated rapidly in the liver, and then decreased gradually, being disposed of by the liver cells. It was found from these observations that the curve of external counting over the animal's liver is influenced by three factors; ^{131}I concentration in the liver, in the blood, and its amount excreted into the bile. This method of ^{131}I rectal injection was clinically applied to 76 cases of patients with and without liver diseases, and the equilibrium time required for this curve to reach a plateau was measured. These values were as follows; control, 7.6 min ± 2.7, gastric cancer without liver metastasis, 9.2 min ± 3.9, obstructive jaundice, 9.6 min ± 4.4, serum hepatitis, 9.6 min ± 0.9, acute hepatitis, 17.4 min ± 4.2, chronic hepatitis, 13.4 min ± 5.3, liver cirrhosis, 18.9 min ± 6.3, primary liver cancer, 20.3 min ± 4.5, and metastatic liver cancer, 25.3 min ± 6.4. It was found that the prolongation of the equilibrium time indicates the liver disorders, but these values were not useful for differential diagnosis because they overlap one another. If the pattern of initial rising of this curve was used with the equilibrium time, each liver disease was more exactly diagnosed, but the exact differential diagnosis could not be obtained. It seems that this method is clinically useful only as an aid to the diagnosis of liver disorders. (auth)

6723 PHOSPHORUS METABOLISM OF BARLEY EMBRYOS IN RELATION TO RADIATION DAMAGE. Ehrenberg, L.; Faludi-Daniel, A. (Univ. of Stockholm. Eotvos Lorand Univ., Budapest). Radiat. Bot., 7: 409-14(Oct. 1967).

X or γ irradiation of resting barley seeds strongly decreases the uptake of phosphate in the embryos germination, whereas the uptake of water is not affected by irradiation. The decrease of phosphate uptake depends on the water content and post-irradiation storage of seeds in the same way as the radiation induced inhibition of seedling growth and other radiobiological lesions. A fractionation, by a somewhat modified Schmidt-Thannhauser procedure, of the embryo material following absorption of phosphate-^{32}P showed that no major process of phosphate incorporation is affected to the same degree as the (active) absorption of the phosphate. After 20 hr

germination at 18°C in phosphate solution the relative incorporation into the acid soluble fraction was somewhat lower, and into the alcohol soluble fraction and possibly some other fractions, slightly higher following irradiation. (auth)

6724 STANDARDIZATION OF ^{14}C STOCK SOLUTIONS USING SCINTILLATION AND BIOLOGICAL METHODS IN PRIMARY PRODUCTION STUDIES. Nair, P. V. Ramachandran (Central Marine Fisheries Research Substation, Ernakulam, India). pp 15-20 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

Cultures of Chlorella pyrenoidosa and C. vulgaris were grown in Osterlind's medium; 500 ml of the culture and 0.1 ml of $NaCO_3$ solution containing approximately 4 to 5 μCi of ^{14}C were used. The absolute activities of the stocks were determined using the $BaCO_3$ technique, scintillation counting, and zero thickness activity method of calculation. It was concluded that both the scintillation technique and the biological technique could be safely used whereas the $BaCO_3$ technique of determining the added activity should be discarded. (B.H.S.)

6725 SIMPLE DOUBLE ISOTOPE TRACER TECHNIQUE FOR THE MEASUREMENT OF FECAL RADIOACTIVITY. Desai, K. P.; Ganatra, R. D.; Mehan, K. P.; Ramanathan, P.; Jeejeebhoy, K. N. (Atomic Energy Establishment, Trombay, India). pp 122-30 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

A new double isotope tracer technique that provides a true quantitative measure of the absorption of a labeled nutrient without the total collection of fecal material is described. Chromium-51-labeled chromic oxide (unabsorbable marker) and ^{59}Fe-labeled vitamin B_{12} (test substance) were administered simultaneously to patients by mouth in the proportion of 1:5 respectively. Stool samples were collected at 24 and 48 hours and counted with a 4.5" NaI scintillation crystal connected to a single channel analyzer and a scaler. The two isotopes were easily distinguished on the basis of energy by using appropriate base level cut-offs with the γ-ray spectrometer. The overall percentage absorption of vitamin B_{12} was computed using the following formula: % absorption of the test substance = $R_1 - R_2/R_1 \times 100$; R_1 is the injection ratio of test substance to marker and R_2 is the ratio in the feces of the test substance to the marker. Correlation of the results obtained using this technique and those obtained by blood level analysis, total fecal collection, and whole-body counting was good. (B.H.S.)

6726 ON THE KINETICS OF INCORPORATION OF ^{32}P IN DNA OF LEUKOCYTES IN TROPICAL EOSINOPHILIA. Bhattacharjee, S. K.; Chatterjee, S. N. (School of Tropical Medicine, Calcutta). pp 415-22 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

The kinetics of incorporation of ^{32}P in the DNA of leukocytes of patients with tropical eosinophilia was studied in order to determine the life span of the disease leukocytes. A tracer dose of ^{32}P was administered to the patients, blood samples were collected daily, DNA was isolated from the white cells, and radioactivity in the DNA was determined. The rise in DNA activity was rather slow up to 24 hr, it then rose very rapidly and peaked on the third day. Thereafter, the activity declined almost equally as rapid until the sixth day and then very slowly over a long period. Granulocytes, constituting the majority (80 to 90%) of the leukocytes, had a life span of 3.3 days; the majority of the granulocytes were eosinophils (60 to 70% of leukocytes). The life span of 12.5 days as determined for the minority of leukocytes in tropical eosinophilia was comparable to the life span of normal leukocytes. (B.H.S.)

6727 CRITICAL ANALYSIS ON HEME AND NON-HEME IRON OF BONE MARROW WITH RADIOACTIVE IRON. Hosain, Fazle (Banaras Hindu Univ., India). pp 403-14 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

An analysis of bone marrow iron both from a theoretical and an experimental approach with respect to Fe kinetics was made. Theoretical values of the % of non-heme Fe with respect to bone marrow Fe were calculated using the Fe kinetics model that was outlined; results are presented in tabular form. Experimental analyses consisted of determining the % of ^{59}Fe in circulating erythrocytes (RBC) in early phase and in vitro heme synthesis. As expected from the theoretical considerations, a large pool of non-heme Fe could not be identified with experimental methods; packed RBC radioactivity remained well below a 1% level 12 hr after the administration of the ^{59}Fe. The release of Fe to circulating RBC via bone marrow started around 12 hr after administration. Within this period a large non-heme pool build up was anticipated theoretically but even the direct in vitro experiments did not reveal its existence; over 80% of the Fe was found as heme Fe in an hour. No conclusions were drawn. (B.H.S.)

6728 PRELIMINARY STUDIES OF THE ABSORPTION AND TRANSLOCATION OF ^{210}Po AND ^{210}Pb IN PLANTS. D'Souza, T. J.; Mistry, K. B. (Atomic Energy Establishment, Trombay, India). pp 381-401 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

The accumulation of ^{210}Pb, ^{210}Po, and ^{89}Sr by Phaseolus vulgaris L plants over a seven day treatment period in cultured solution was examined. Both Pb and Po accumulated mostly in the roots, and only very small amounts were translocated to the shoots; Sr was transported up the plant in relatively large amounts. On a total plant basis, the percent uptake of Pb and Po was greater than that for Sr. The values for percent uptake and accumulation factors for Pb were higher than those of Po by an order of magnitude. While massive accumulation of Pb and Po occurred in the roots, significantly higher concentrations were present in the stem as compared with the leaves. Strontium accumulation factors for stems and leaves were higher and those for roots were lower than the corresponding Pb and Po accumulation factors. The effects of salt concentration of the culture solution, citrate ions, 2,4-dinitrophenol, and deionized water on the accumulation and retention of these radioisotopes were also investigated. (B.H.S.)

6729 STUDIES ON THE ENZYME SYSTEM CONCERNED WITH THE EXCHANGE OF ^{131}I WITH IODINE OF MONOIODOTYROSINE. Ray, Manju; Datta, Asoke G. (Indian Inst. for Biochemistry and Experimental Medicine, Calcutta). pp 335-42 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

The properties of an enzyme preparation that catalyzed the exchange between added ^{131}I and nonradioactive iodine of monoiodotyrosine (MIT) were investigated. The enzyme preparation consisted of the supernatant from an homogenate of the submaxillary gland of the rat. The enzyme was incubated with MIT or tyrosine, KI, $CuCl_2$ and carrier-free ^{131}I; products of the reaction were identified by chromatographic and autoradiographic techniques. It was found that the enzyme catalyzed iodination of tyrosine and MIT to MIT and diiodotyrosine (DIT) respectively. Formation of MIT from tyrosine was dependent on cupric ion whereas DIT was not. Results indicated that an exchange between the added ^{131}I and the I of MIT took place under the influence of the enzyme preparation. (B.H.S.)

6730 BIOCHEMICAL LESIONS INDUCED IN SUBCELLULAR STRUCTURES BY IONIZING RADIATION. V. THE ACTIVITY OF ALKALINE AND ACID PHOSPHATASES IN RAT LIVER AND SPLEEN. Hurwic, Maria; Dancewicz, Antoni M. (Inst. of Nuclear Research, Warsaw). Nukleonika, 12: 577-87(Aug. 1967).

The activity of both alkaline and acid phosphatases was assayed in rat liver and spleen homogenates and in subcellular fractions isolated therefrom. The assays were performed at 0, 2, and 24 hours after exposure of rats to a dose of 750 R of whole-body x irradiation. The irradiation increases the activity of both phosphatases in spleen. The increase in specific activity of alkaline phosphatase was found in mitochondrial, microsomal, and soluble fractions of the spleen, while the specific activity of acid phosphatase (free and total) was found to increase in the microsomal (lysosomal) fraction of this organ. In liver the irradiation causes transient (at time 0) decrease in the specific activity of both phosphatases in nuclear and mitochondrial fractions, and a slight decrease in the activity of acid phosphatase in the microsomal fraction. No changes in the intracellular distribution of both enzymes were found after irradiation in vivo. (auth)

6731 MEASUREMENT OF THE AMOUNTS OF THOROTRAST DEPOSITED. Ookawara, Shigeyuki; Okazima, Shunzo; Abe, Takeo (Nagasaki Univ.). Nagasaki Igakkai Zasshi, 40: 662-5(Aug. 1965). (In Japanese).

Thorotrast is a 24 to 26% colloidal suspension of ThO_2 and has been widely used for the roentogenography of blood vessels, liver,

spleen, and other organs. Some disorders as a result of Thorotrast administration are reported, and the measurement of Thorotrast deposited in some organs is discussed. At the time of Thorotrast administration ^{232}Th and ^{228}Th are presumably in equilibrium. About 10% of administered Thorotrast is excreted and ~90% absorbed in liver, spleen, and bone. Some of the daughter nuclei formed from absorbed Thorotrast in liver and spleen and a small part of those in bone are transferred to other organs. Some α-ray energy may be lost due to self-absorption, in liver and bone ~50% and in spleen ~75%. However, the loss of β radiation by self-absorption is negligible. The cumulative doses, in Rem, for 1000 g of liver, 100 g of spleen, and 1500 g of bone at 10 yr after administration of 20 ml of Thorotrast in the human body were estimated to be: liver 3149 to 5265 α and 4.9 β; spleen 1597 to 2876 γ and 14.2 β; bone 10.8×10^{11} α and 24.3×10^{10} β. It was considered that the ratio of Thorotrast deposition in liver, spleen, and bone was 70:20:10. However, experimental results showed that the Thorotrast deposited in liver and spleen was less and the amount in bone was more than the value considered. (BBB)

6732 THE INFLUENCE OF CERTAIN UV WAVELENGTHS ON THE HYPOPHYSIS OF WHITE MICE (MUS MUSCULUS L.). Lach, Henryk (Teacher Training Coll., Krakow). Acta Biol. Cracov., Ser. Zool., 9: 1-16(Jan.-May 1966).

The effect of uv radiation at different doses and intensities on the hypophysis of the mouse was investigated. Histochemical studies showed that uv radiation affected the distribution of DNA, RNA, and of periodic acid Schiff-positive substances. The mice of the first group were irradiated over 28 days, for 15 min daily at 289 to 405 nm, with an energy of 52,800 erg/sec/cm^2. The second group was exposed in the same spectral range and the same energy but with a dose of 30 min daily for four weeks. The third group was irradiated daily for 15 min over 28 days at a wavelength of 254 to 405 nm and an energy of 63,400 erg/sec/cm^2. The fourth group was exposed in the same range and the same energy as group three for 30 min over four weeks. Secretory activity in the hypophyses of mice irradiated with uv increased, as results from the first and second groups showed, corresponding to greater hormone production. In the third, and especially the fourth group, however, an inhibitory influence of uv was observed on the endocrine function of the hypophysis. This was revealed by the degranulation of α cells, massive disintegration of basophil cells, and the large number of pyknotic nuclei. The degree and nature of the endocrine secretory changes did not depend solely on the quality of the irradiation but also on the magnitude of the dose, i.e., the intensity and duration of the irradiation. (BBB)

6733 THE INVESTIGATION OF THE QUINONE FORMATION IN IRRADIATED COTTON SEEDS. Tulaganov, A.; Ibragimov, A. P. Uzb. Biol. Zh., No. 3, 8-10(1967). (In Russian).

The formation of quinones in the γ irradiated cotton seeds treated by different doses was investigated. The dynamics of quinone accumulations in different organs of plants grown from the irradiated cotton seeds were also studied. A number of the quinones formed in gossypol glandules obtained from the irradiated cotton seeds were determined. (auth)

6734 FREE RADICALS AND THEIR INTERACTIONS IN SOLID MOLECULAR MIXTURES. Henriksen, Thormod; Sanner, tore (Norwegian Radium Hospital, Oslo). Radiat. Res., 32: 164-75(Sept. 1967).

Solid mixtures of Sephadex and penicillamine, irradiated at 77°K, were studied by ESR technique. Sephadex is a modified dextran containing a network of interstices and pores. The degree of mixing between Sephadex and penicillamine was altered by varying the amount of water in the suspension prior to lyophilization. It was found that the qualitative and quantitative ESR spectra depend strongly on the extent of contact between the two components of the mixture. Evidence was obtained that secondary reactions, resulting in transfer of radiation energy from Sephadex to penicillamine, take place at 77°K. On heat treatment of the mixtures, irradiated at 77°K, the organo-sulfur radicals $R-C(CH_2)_2-S^{\cdot}$ were formed to a much greater extent than if no intermolecular reactions had taken place. The results demonstrated that the formation of sulfur radicals increased with the degree of mixing between the two components. (auth)

6735 CURRENT PROBLEMS IN LASER MICROPROBE ANALYSIS. Rosan, Robert C.; Brech, Frederick; Glick, David (Stanford Univ., Palo Alto, Calif.). Fed. Proc., 24: Transl. suppl. 14, 126-8(Jan.-Feb. 1965).

When a focused laser discharged on a biological target, a crater was formed from which a plasma of energized gases recoiled explosively. The plasma comprised the excited atomic constituents of the sample at the focal point of the laser beam. Hit with a 0.1-J output from a Q-spoiled laser focused to a 100μ spot, the plasma heated to ~10,000°K and transition energies approached 2 eV. From these transitions, atomic spectra extending into the deep uv, characterized by intense broadening and even self-reversal, were produced. When the excited plasma short circuited a 1- to 2-kV potential across a small electrical gap, ions in the plume produced a spark discharge. In this spark, atomic transitions of about 12 eV occurred that elicited characteristic spark atomic spectra. Although these spectra were not as rich in lines, nor of exactly the same patterns, as ordinary spark spectra, they could be used qualitatively to determine which elements were present and quantitatively to estimate their concentrations. Such analytical uses of the laser in biological systems were discussed, and it was pointed out that study of these analytical techniques could lead to insight into the interactions that occurred. It was concluded that the craters excavated by Q-spoiled lasers could differ from those obtained with ordinary lasers, even when the same rod and pump were involved. (BBB)

6736 PRELIMINARY RESULTS OF THE EFFECT OF LASER MICROBEAM ON CELLS IN VITRO. Squassabia, A. B.; Longostrevi, G. Poggi (Univ., Milan). Boll. Soc. Ital. Biol. Sper., 41: 1593-6(Dec. 31, 1965). (In Italian).

A comparison was made of the effects of laser radiation and x rays on cells cultured in vitro. A ruby laser was used with a microscope system to focus microbeams on amniotic cells of the Ha-Lilly type. Beams of diameters are small as 5μ were generated at an input of 400 J, providing an energy at the target of 0.2 J. The living cells did not immediately show any visible effects of laser irradiation. Only after staining were the effects revealed. Nuclear damage was not seen, in contrast to cells exposed to 1000-R doses of x rays, in which nuclei in telophase were seen to undergo fragmentation and to migrate toward the peripheral regions of the cell. With the ruby laser, intravital staining could be used to selectively destroy structures which took up dyes that specifically absorbed the wavelength (6943 Å) at which the laser operated. By selectively staining the nucleus, nucleoli, mitochondria, and other organelles it should be possible to damage them without producing widespread cellular injury. (BBB)

6737 THE EFFECT OF POTASSIUM ON NICOTINE-INDUCED CONTRACTURE AND ^{45}Ca MOVEMENTS IN FROG SARTORIUS MUSCLE. Weiss, George B. (Medical Coll. of Virginia, Richmond). J. Pharmacol. Exp. Ther., 154: 595-604(Dec. 1966).

The contracture and 3-fold increase in ^{45}Ca uptake induced by nicotine (1.25 to 5.0 mM) in frog sartorius muscle were inhibited by prior exposure of the muscle to Ringer's solution containing 80 mM K^+. The inhibition of increased ^{45}Ca uptake by K^+ also occurred at concentrations of nicotine (0.415 to 0.83 mM) too low to elicit recordable contractures. The rate of ^{45}Ca uptake was maintained for a full 10-min incubation period at lower nicotine concentrations (0.415 and 0.83 mM), whereas more then five-sixths of the increased ^{45}Ca uptake at 2.50 mM nicotine occurred during the first 5 minutes of a 10 minute incubation period. Resting ^{45}Ca uptake was also inhibited by prior administration of K^+. Prolonged washout in Ca-free Ringer's solution containing 4 mM EDTA did not prevent a nicotine-induced contracture which was accompanied by an increased ^{45}Ca efflux. Under these conditions, 80 mM K^+ inhibited the contracture but not the increased ^{45}Ca efflux. These observations suggest that the inhibition of nicotine-induced ^{45}Ca uptake and contracture by 80 mM K^+ is a result of prior displacement by K^+ of that store of bound Ca^{2+} normally released by nicotine. The actions of nicotine may occur at different Ca sites from those affected by other agents which induce contracture in frog sartorius muscle. (BBB)

6738 THE EFFECT OF pH ON NICOTINE-INDUCED CONTRACTURE AND ^{45}Ca MOVEMENTS IN FROG SARTORIUS MUSCLE. Weiss, George B. (Medical Coll. of Virginia, Richmond). J. Pharmacol. Exp. Ther., 154: 605-12(Dec. 1966).

The contracture and three-fold increase in ^{45}Ca uptake induced by 2.5 mM nicotine in frog sartorius muscle could be inhibited by lowering the pH of the Ringer's bathing solution from 8.4 to 7.4. The nicotine-induced contracture and ^{45}Ca efflux obtained at pH 8.4 after prolonged washout in Ca-free Ringer's solution containing 4 mM EDTA were also inhibited by decreasing the pH to 7.4. If the amount of nicotine in pH 7.4 Ringer's solution was raised to 10 mM, the concentration of nonionized nicotine was equal to that present in pH 8.4 Ringer's solution containing 2.5 mM nicotine. The contracture and increased ^{45}Ca uptake induced by 10 mM nicotine in the pH 7.4 Ringer's solution did not differ significantly from that obtained using pH 8.4 Ringer's solution containing 2.5 mM nicotine. The uptake of ^{14}C-labeled nicotine into frog sartorius muscles was more than doubled by increasing the pH of the Ringer's solution from 7.4 to 8.4. These observations indicated that the magnitude of the nicotine-induced contracture and ^{45}Ca movements is dependent upon the concentration of nonionized nicotine in the bathing solution. Thus, the nonionized form of nicotine appeared

to be the molecule of importance not only for penetration of the cell membrane, but for alterations in ^{45}Ca movements and contracture tension in frog sartorius muscle. (BBB)

6739 RELATIONSHIP OF ASH CONTENT AND STAGE OF GROWTH TO RADIOSTRONTIUM UPTAKE BY WHEAT. Lee, C. C.; Sosulski, F. W. (Univ. of Saskatchewan, Saskatoon, Can.). Can. J. Plant Sci., 47: 320-2(1967).

When Thatcher wheat was grown in ^{90}Sr-treated soil and the harvested grain milled into bran, shorts, and flour, the radioactivities of these milled products were directly proportional to their ash contents. Flour, which contained the least ash, was lowest in ^{90}Sr activity. Since most of the grain ash was concentrated in the bran, studies were done to determine if decreasing the bran contamination in the flour would result in proportionately lower levels of radioactivity in the flour. Wheat was grown in soil containing 0.05 mCi of carrier-free ^{85}Sr per plant. Portions of grain harvested from these plants were milled to yield 41.5, 51.5, 58.5, and 70.4% of flour. Although differences were not large, the low extraction flours contained the least ^{85}Sr activity. Milling to progressively higher yields of flour resulted in increased concentrations of ash and ^{85}Sr in the clears and shorts. To determine whether the relation of radiostrontium uptake to ash content would also hold for other plant tissues, eight varieties of spring wheat were grown in ^{85}Sr-treated soil, and radioactivity and ash content of the leaves, stems, chaff, grain, and whole plant were determined. A positive correlation between ^{85}Sr and ash contents of the leaves was found. Approximately 65% of the total ^{85}Sr of the plants was concentrated in the leaves. (BBB)

6740 THE APPLICATION OF NEUTRON ACTIVATION ANALYSIS TO FORENSIC SCIENCE. Coleman, R. F. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Forensic Sci. Soc., 6: 19-22(Jan. 1967).

Principles of activation analysis and various associated experimental techniques are discussed, and some applications to forensic science problems are considered. After neutron irradiation there are many possible ways of determining the induced activity in the sample. The simplest and usually the most sensitive, but at the same time the most time-consuming method, involves dissolution of the sample followed by chemical separations of the desired activity from the remainder and then counting the activity with a β counter. The most widely used nondestructive method of determining the activity of the sample involves γ spectrometry. Use of computer methods of analysis for rapid and routine analysis by activation methods are described. To obtain satisfactory results from computer methods it is important to have a very stable system. Control of drift that arises from both gain and threshold changes in the system as studied by two methods is discussed. Also considered are problems of resolving of the γ spectra, and the sensitivity of neutron activation analysis for various elements. A 20-fold improvement in resolution can be obtained by use of lithium-drifted germanium detectors as a replacement for sodium iodide crystals for γ spectrometry. Distribution of concentration of 13 trace elements in human hair throughout human populations is outlined, as well as hair analysis for use in criminal investigations to provide quantitative information associating a hair with a particular individual. With the aid of background details collected with the hair samples, it was shown that there is some correlation of certain trace elements with sex, geographical location, and occupation. (BBB)

6741 ACQUIRED RADIORESISTANCE OF TUMOUR CELLS. Balmukhanov, S. B.; Efimov, M. L.; Kleinbock, T. S. (Kazakh Research Inst., Alma-Cita, USSR). Nature (London), 216: 709-11(Nov. 18, 1967).

The mechanism of the enhancement of tumor radioresistance, as a result of repeated irradiation, is unknown. In the studies described radioresistant strains of Ehrlich ascites tumors in mice were obtained. This was achieved by intraperitoneal reinoculation, preceded by irradiation of the tumor with 300 R in vivo for three consecutive days and a single dose of 1000 R in vitro. When the inoculation material was irradiated with doses of 1000 and 2000 R the tumor grew much more rapidly than a control tumor. Inoculation with 10^6 cells did not result in any development of the control tumor, whereas the chronically irradiated tumor showed marked growth. Similarly, with irradiation doses varying from 1000 to 3000 R and a constant number of inoculated cells, the number of animals in which tumors developed was greater when the repeatedly irradiated cells were used. The DNA content of repeatedly irradiated strains was less than that of the initial tumor. Cytochemical investigation of histidine revealed two types of cells, with high and with low histidine concentrations. After irradiation with 1500 R cells with high histidine content accumulated in the radioresistant strain, while the initial control tumor showed fewer of such cells. The content of sulphydryl groups in soluble proteins of radioresistant strains was also much greater than in cells of the control strain. An increase of PSH groups (sulphydryl groups bound to protein) was observed in radioresistant tumor obtained by repeated irradiation. A further finding was that the content of A-globulins was greater in the radioresistant strains than in the initial control strain, but on the third day after irradiation with 1500 R the A-globulins decreased in the former, and increased in the latter, while the content of B-globulins markedly increased in the radioresistant strain. These findings are discussed. It is noted that lipoproteids are highly radioresistant and may play an active part in these processes. In connection with chromosome studies, it appears that a characteristic of development of radioresistance is an increase in cells with low chromosome numbers. (UK)

6742 REPAIR REPLICATION IN HeLa CELLS AFTER LARGE DOSES OF X-IRRADIATION. Painter, R. B.; Cleaver, J. E. (Univ. of California, San Francisco). Nature (London), 216: 369-70(Oct. 28, 1967).

Studies are described showing that, after very large doses of x-rays to HeLa cells, incorporation of precursors into DNA occurs as a result of a process having the characteristics of "repair-replication," which process has been correlated with enhanced survival in bacteria. Cells were grown in Eagle's medium containing 5 μg/ml bromouracil deoxyriboside (BUdR), followed by incubation in normal Eagle's medium before x-irradiation to 100,000 R (300 kVp, 3,400 R/min). Immediately after irradiation a medium containing 5 μC/ml. ^3H-thymidine (^3HTd R-11) was added and the cells incubated again before making density gradient analyses. A ^{14}C-BUdR-grown HeLa S3 DNA standard was added to define the position of BUdR-substituted DNA in the gradients. In the control only one tritium peak was observed, appearing at the density expected for unsubstituted DNA, whereas in the gradient from irradiated cells there was also a tritium peak in the hybrid portion at the position of the ^{14}C-BUdR-DNA marker. Thymidine was incorporated into the DNA strands already formed which contained bromouracil. Semi-conservative DNA replication also occurred in these cultures to a low level. Experiments were also performed to determine whether the process occurred in DNA of normal density; a low level of semi-conservative replication was again indicated. BUdR was incorporated into molecules of normal density at such low frequency that their density was not appreciably affected. Under the conditions of the experiments any incorporation occurring as a consequence of semi-conservative replication must have resulted in tritium incorporation exclusively into heavy DNA strands. The observed incorporation could therefore only have resulted from insertion of ^3H-BUdR into previously existing DNA molecules. This "repair replication" could not be demonstrated unequivocally at doses <50,000 R, and it may be a pathological response caused by high dose. It is more likely, however, that it occurs at low doses, but is obscured by the relatively massive incorporation of tritium resulting from normal semi-conservative replication. It is strongly suggested that mammalian cells possess means whereby they can repair damaged DNA. (UK)

6743 STUDY OF THE IN VIVO DISTRIBUTION OF FERRIC, CALCIUM, AND CHROMIC PHOSPHATES (^{32}P). Anghileri, Leopoldo Jose (Deutsches Krebsforschungszentrum, Heidelberg). J. Nucl. Biol. Med., 11: 17-19(Jan.-Mar. 1967).

The comparative study of the in vivo distribution of ferric, calcium and chromic phosphates (^{32}P) indicates that, on the contrary of the chromic phosphate, the ferric and calcium phosphates are readily hydrolyzed and the radiophosphorus activity excreted. This unstability rules out the use of those insoluble phosphates as internal beta irradiation agents. (auth)

6744 AN ATTEMPT OF PREVENTING OF LYMPHOID ATROPHY IN SECONDARY DISEASE OF IRRADIATION CHIMERA BY ADMINISTRATION OF LYMPHOCYTES FROM A RECIPIENT. Koval'chuk, L. V.; Zaretskaya, Yu. M. (Inst. of Biophysics, Moscow). Byull. Eksp. Biol. Med., 64: 82(Oct. 1967). (In Russian).

Mice of CBA and C3H strains lethally irradiated and protected by rat bone marrow on the 15th, 23rd, and 24th days received cells of an isologous spleen. Additional administration of isologous lymphocytes at the same periods proved to be of little effect in preventing lymphoid atrophy and did not prevent the development of secondary disease in the animals. (auth)

6745 EFFECT OF IMMUNIZATION ON THE KINETICS OF ^{90}Sr ELIMINATION AND CERTAIN INDICES OF NATURAL IMMUNITY. Nevstrueva, M. A.; Livshits, R. E.; Shubik, V. M. (Leningrad Scientific-Research Inst.). Gig. Sanit., 9: 44-7 (Sept. 1967). (In Russian).

The effect of immunization with bacterial, virus, and soluble antigens on the elimination of strontium-90 from the bone tissue and that on other indices of the natural immunity was studied in

experiments carried out on 320 albino rats. The immunization was carried out three times at intervals of 7 days; the antigen in form of vaccines and live cultures was introduced subcutaneously and intraperitoneally. Strontium-90 at a concentration of 50 μC was administered per os 7 days after the immunization. The immunization of rats with bacterial (proteus vulgaris) and virus (influenza A virus) antigens caused a temporary rise of certain indices of the natural immunity. However, the immunization of animals with bacterial, virus, and soluble antigens increased the deposition of strontium-90 in the rat skeleton. (auth)

6746 EFFECT OF FLUORINE IN DRINKING WATER ON THE EXTENT OF STRONTIUM ACCUMULATION IN THE HUMAN BODY. Knizhnikov, V. A. Gig. Sanit., 7: 39-45(July 1967). (In Russian).

The content of calcium, fluorine, strontium-90, and stable strontium was studied in drinking water and various components of the diet of the population in several towns. The content of these elements was also determined in thousands of teeth extracted from adults and children. The amount of strontium accumulated in the bone tissue of the adult population was increased, depending on the content of fluorine in water, from 285 (fluorine content of 0.1 mg/l) to 135 times (fluorine concentration of 4 mg/l) and in the skeletons of children, aged 7 to 13 years, was increased from 158 (fluorine concentration of 0.1 mg/l) to 85 times (fluorine concentration of 1.2 mg/l) that was found in control populations. No effect of fluorine on the calcium content of skeleton was seen. (auth)

6747 DISTRIBUTION MEASUREMENTS FOR TESTING NEW DEVICES OF INSECTICIDE AND FUNGICIDE SPREADING. Helbig, W.; Beer, M.; Kuhn, E. Isotopenpraxis, 3: 334-8(1967). (In German).

For testing the homogeneity of distributions of sprayed and atomized pesticides spread from air-borne or car-borne devices, new techniques of labeling with ^{198}Au were developed. Leaves of the plants or blank films exposed on the area to be investigated were measured using an automatic counting device. The method is part of testing new devices for pesticide spreading. (auth)

6748 PRODUCTION OF RADIOACTIVE MYXIN. Lesley, S. M.; Behki, R. M.; Gillespie, D. C. (Canada Department of Agriculture, Ottawa). Can. J. Microbiol., 13: 1251-7(Oct. 1967).

Uniformly labeled glucose-^{14}C of a high specific activity was supplied to growing cells of a species of Sorangium (strain 3C) under specified conditions. The antibiotic myxin that was synthesized by the cells contained about 10% of the ^{14}C supplied. Because of its specific activity, the purified antibiotic could be used at low concentrations in experiments designed to investigate the site and mechanism of action of this compound with susceptible cells. (auth) (Canada)

6749 DINITROPHENOL DECREASES THE RADIATION SENSITIVITY OF L CELLS. Dalrymple, G. V.; Sanders, J. L.; Baker, M. L. (Arkansas Univ. [Fayetteville]). Nature (London), 216: 708-9(Nov. 18, 1967).

The repair of radiation injury would appear to consume energy chiefly in the form of ATP, and studies are reported on the response to radiation of L cells severely depleted of intracellular ATP. It was found that 2,4-dinitrophenol (DNP) can reduce intracellular ATP by about 90%; also that L cells treated with DNP for up to eight hr lose none of their reproductive integrity, and are less sensitive to radiation, particularly at high doses. The experimental technique is described in detail. Irradiation was with spaced doses of x-rays (150 kVp, 15 ma, 6 mm Al HVL, dose rate 100 R/min). Post-irradiation survival curves are shown for control and DNP treated cells. The results of a toxicity study with DNP are also described; there was no evidence of toxicity up to eight hr of contact. In experiments on the reduction of ATP intracellular concentration by DNP, it was found that although the latter produced a rapid decrease in concentration, rapid increase occurred after removal of DNP. It is noted that DNP acts on ATP by uncoupled mitochondrial oxidative phosphorylation, and that short periods of ATP deficiency are compatible with viability, normal colony growth and increased resistance to ionizing radiation. Immediately after DNP treatment synthesis of DNA, RNA and protein in the cells virtually stops, and the increased survival after irradiation is paralleled by, and is possibly a result of, a depression of macromolecular synthesis. (UK)

6750 UNCOUPLING OF OXIDATIVE PHOSPHORYLATION IN RAT LIVER AND SPLEEN MITOCHONDRIA BY EXPOSURE TO TOTAL-BODY IRRADIATION. Yost, Martha T.; Robson, Hope H.; Yost, Henry T. (Amherst Coll., Mass.). Radiat. Res., 32: 187-99(1967).

To examine the suggestion that the uncoupling of oxidative phosphorylation by exposure to whole-body ionizing irradiation is an artifact produced during isolation of the mitochondria, several methods of extraction and of assay were tested, including those reported to have removed the effect. Significant uncoupling of oxidative phosphorylation was observed, in both liver and spleen mitochondria, when assays were made 24 to 48 hours postirradiation. Failure to observe uncoupling can be attributed to early assay, in most cases. Sources of variability in the uncoupling response have been examined including fluoride and mitochondrial assay concentrations, time of assay, time of irradiation, energy of the radiation, and season of year. In phosphorylation accompanying the oxidation of reduced cytochrome c in liver, there is the suggestion of a seasonal effect, the mitochondria showing lower inactivation during the spring and summer months. However, the effect is largely on the control P/O values. The observed variability of response is primarily dependent on intrinsic differences in the rats, as would be expected if the effect were abscopal. (auth)

6751 CHANGES IN SERUM PROTEINS IN EXPERIMENTAL MASUGI NEPHRITIS OF RABBITS AFTER X-RAY IRRADIATION. I. Metev, M. (Higher Military Medical Inst., Sofia); Izmirov, I.; Berchev, K. Voenno Med. Delo, 22: No. 2, 50-6(Apr. 1967).

The content of serum proteins in rabbits with experimental Masugi nephritis was determined after the rabbits had been irradiated with x-rays in a dose of 600 R. The most pronounced changes were found 16 days after injection of the nephrotoxic Masugi serum (five days after irradiation). They comprised a decrease in albumins and γ-globulin and an increase in β_2-globulin. As compared with controls that had no nephritis and were subjected to the action of radiation alone, there was an increase in α_1-, β_2-, and γ-globulins and a decrease in β_1 globulin. The total protein content was increased compared with the initial and that of rabbits subjected to the action of radiation alone. Changes in the immunogram indicated that irradiation had an effect not only on the synthesis of proteins in general, but also on that of antibodies. Nonirradiated rabbits with nephritis exhibited dysproteinemia of the II type according to G. Riva. They showed an increase in β-globulins and a decrease in albumins and γ-globulin. (JPRS)

6752 PLASMA PROTEIN SYNTHESIS FOLLOWING NEUTRON IRRADIATION. Baker, D. G.; Carsten, A.; Jahn, A.; McFadyen, D. (Brookhaven National Lab., Upton, N. Y.). Radiat. Res., 32: 265-76(1967).

The incorporation of ^{14}C-glycine into the plasma proteins of rats at 3, 10, and 30 days following whole-body irradiation with fast neutrons was measured. Only at three days postirradiation did the specific activity of the proteins from the irradiated rats exceed that of their pair-fed controls. The early decrease in concentration of plasma proteins was shown to result from anorexia, while the late (30 days) decrease seemed more likely to result from damage to the synthetic process. At all time intervals, the release of labeled proteins following the injection of ^{14}C-glycine was more delayed in the irradiated rats. (auth)

6753 RESPONSES OF SYNCHRONOUS POPULATIONS OF HeLa CELLS TO ULTRAVIOLET IRRADIATION AT SELECTED STAGES OF THE GENERATION CYCLE. Djordjevic, Bozidar; Tolmach, L. J. (Washington Univ., St. Louis). Radiat. Res., 32: 327-46(1967).

Synchronous HeLa S3 cultures were exposed to ultraviolet light at selected times in the generation cycle. Dose-survival curves show changes of both slope and extrapolation number. Sensitivity, measured as loss of colony-forming ability after doses of 70 ergs mm^{-2}, increase late in G_1, reaches a maximum in the middle of S, and decreases through the remainder of S and G_2. The maximum occurs later than does the interphase maximum observed after x-irradiation with doses yielding about the same surviving fraction of cells. After doses up to 70 ergs mm^{-2}, progression of cells from from G_1 to S or from G_2 to mitosis is not blocked. Cells irradiated in G1 or S show a marked inhibition in the rate of incorporation of thymidine. The duration of DNA synthesis appears to be increased, resulting in a delay in cell division. Cells that die appear to do so largely before the first division after doses above 35 ergs mm^{-2}. Incorporation of thymidine was detected in G_1 and G_2 cells after irradiation, the maximum amount measured after three hours of incorporation following a dose of 140 ergs mm^{-2} corresponding to less than 1% of the DNA synthesized during a normal generation cycle. Incorporation of tritiated thymidine of high specific activity during this unscheduled synthesis decreases survival. Treatment with hydroxyurea, but not fluorodeoxyuridine, for 12 hours after irradiation in G_1 also decreases survival, but does not inhibit the unscheduled incorporation of thymidine. (auth)

6754 KINETICS OF UPTAKE AND ELIMINATION OF ^{90}Sr. Moskalev, Yu. I.; Buldakov, L. A. Radiobiologiya, 7: 381-4 (1967). (In Russian).

Strontium-90 in equilibrium with ^{90}Y was given perorally to rats at dose of 0.00051 μCi per day for 600 days or 0.012 μCi per day for 385 days and to dogs at a dose of 0.01 μCi per day for 1024 days. Determination of the ^{90}Sr in the skeleton of the animals indicated that a dynamic equilibrium between uptake and elimination of ^{90}Sr developed that corresponded to maximum accumulation of 7.2 times the daily dose in the skeleton of adult rats (4 to 7 months old in the beginning of the experiment) and 17.45 times the daily dose for young rats (1 to 1.5 months old in the beginning of the experiment). The maximum accumulation factor did not depend on the magnitude of the daily dose. The accumulation of the isotope in the skeleton of dogs at the equilibrium point amounted to 44 ± 2.5 times the daily dose. The maximum effective half-time of elimination of ^{90}Sr from the skeleton was 533 and 593 days for rats on administration of the isotope for 385 and 600 days, respectively, and 530 days for dogs on administration of the isotope for 512 days. A calculation showed that estimation of the amount of ^{90}Sr accumulated in the skeleton of rats and dogs after prolonged administration led to results that were too high unless changes in the rates of uptake and elimination with increasing age of the animals were taken into consideration. (JPRS)

6755 PREPARATION OF COLLOIDAL SOLUTION OF ZIRCONYL PHOSPHATE LABELLED WITH ^{32}P FOR RADIOTHERAPEUTIC PURPOSES. PART III. STUDY OF TISSUE DISTRIBUTION AND RETENTION. Hussein, A. M. (Cairo Univ.); Kassem, A. A.; ElGarhy, M.; Abdullah, E. Isotopenpraxis, 3: 327-30(1967).

The tissue distribution of colloidal zirconyl phosphate-^{32}P and its retention following i.m. and i.v. injection in mice were studied. About 63% of the i.m. injected ^{32}P activity was retained as the site of injection after five days, suggesting the use of the colloid in the local treatment of tumors. The deposition of the colloid in bones and liver after i.v. injection presented zirconyl phosphate-^{32}P as useful in the radiotherapy of bone and liver diseases. (auth)

6756 LIGHT AND ELECTRON MICROSCOPIC STUDY OF PRIMATE LIVER 36 TO 48 HOURS AFTER HIGH DOSES OF 32-MILLION-ELECTRON-VOLT PROTONS. Ghidoni, John J. (Baylor Univ., Houston, Tex.). Lab. Invest., 16: 268-86(Feb. 1967).

Structural changes in liver were examined after whole-body exposure of Rhesus monkeys to 6000-rad doses of 32-MeV protons. The protons penetrated to a depth of 1 cm, the animals being rotated during exposure. By 36 to 48 hr postirradiation, the animals developed central nervous system irritability and other clinical signs of nerve cell damage. In liver, the most prominent features of the irradiated hepatocytes were the discrete segmental membrane alterations found focally in parts of mitochondria, rough and smooth endoplasmic reticulum, and microbodies. No cellular participation in the formation of the lesions or cellular response to the submicroscopic lesions was evident. Frequently, submicroscopic lesions were present in adjacent membranes of mitochondria or endoplasmic reticulum, and of large vacuoles. Both mitochondria and endoplasmic reticulum were observed protruding into these vacuoles that may represent dilated cisternae. Poles of mitochondria protruding into vacuoles showed loss of matrix. The marked increase in the shrunken, dark cell population in irradiated liver and the previously reported elevated serum enzyme levels are supporting evidence for the ultrastructural observations of membrane alterations. (BBB)

6757 INCREASED HYDROLASE ACTIVITY IN BETA-IRRADIATED EPIDERMIS AND ITS RELATION TO CELL DEATH. Tabachnick, Joseph; Won Song, Chang; Freed, Richard M.; Perlish, Jerome S. (Albert Einstein Medical Center, Philadelphia). Contract AT(30-1)-3445. J. Albert Einstein Med. Cent., 15: 71-84(Jan. 1967). (NYO-3445-8).

After irradiation of albino guinea pig skin with a dose of 3000 rep beta from a $^{90}Sr-^{90}Y$ sealed source, the increase in acid phosphatase activity or in that of other acid hydrolases occurred too late to be considered a possible cause of radiation cell death. There was an early postirradiation increase in extracellular epidermal DNAase which occurred well before any histologic evidence of injury. It is considered to be highly unlikely, however, that this is an alteration leading to cell death, since this phenomenon was not unique for ionizing radiation injury but could be elicited by even mild trauma, such as clipping or plucking of hair, or superficial scratching of the skin surface. The increase in extracellular epidermal DNAase I appears to be associated with the inflammatory response following skin trauma. Extracellular DNAase I remains elevated in the irreversibly altered epidermis of beta-irradiated skin, but, with milder traumas, it returns to the control level as hyperplasia subsides. Since it precedes or accompanies the epidermal hyperplasia that occurs during regeneration of irradiated skin or healing of superficial wounds, it may play a role in epidermal cell proliferation, rather than cell death. Some indirect evidence was presented in support of the hypothesis that extracellular epidermal DNAase I is primarily of humoral origin and its increase after skin trauma results from increased vascular permeability and diffusion of a DNAase I-inhibitor complex into the epidermis, where the inhibitor is subsequently inactivated or destroyed. The inactive DNAase I in epidermal washings, that can be activated by "aging" or heating 10 min at 55°C., may be the postulated DNAase I-inhibitor complex. (auth)

6758 THE INFLUENCE OF ^{60}Co γ IRRADIATION OF PEA SEEDS ON THE THIAMINE BIOSYNTHESIS IN 10-DAY PLANTS. Kulesza, J.; Moszczynski, P.; Kroh, J. (Politechnika, Lodz). Biol. Plant., Acad. Sci. Bohemoslov., 9: 15-19(1967).

Attempts were made to improve the vitamin level of peas by irradiation of the seed before germination. Pea seeds were subjected to 1, 5, and 20 Krad doses of ^{60}Co γ rays, and then planted in damp sand in Petri dishes. After 10 day incubation at room temperature and under natural light conditions the content of the following components was determined in young plants: free thiamine, thiamine pyrophosphate, and dry substance. It was found that the 1 Krad dose stimulated the growth of the plant and increased the yield of green parts. The doses within the range of 1 to 5 Krad did not affect the production of thiamine. However, the content of thiamine, particularly in its free form, increased markedly after the dose of 20 Krad. However, such doses hampered the vegetation. It was concluded that doses of the order of 1 Krad lead to positive results with respect to the growth of the plants, however, neither thiamine biosynthesis nor its phosphorylation was enhanced under these conditions. (BBB)

6759 RADIOISOTOPE TURNOVER AND ENERGY FLOW IN TERRESTRIAL ISOPOD POPULATIONS. Reichle, David E. (Oak Ridge National Lab., Tenn.). Ecology, 48: 351-66(Late Spring 1967).

Radiocesium turnover rates in terrestrial isopod populations were used to measure food consumption and metabolism under natural and lab-simulated field conditions. Four old-field and forest species were studied: Armadillidium vulgare, Armadillidium nasatum, Cylisticus convexus, and Metoponorthus pruinosus. Uptake, body burden equilibria, and elimination rates for ^{134}Cs were related to environmental temperatures ($Q_{10} \simeq 2$). Dietary supplements of stable Na, K, and Cs salts produced no effect upon ^{134}Cs elimination rates. Assimilation fractions from food were 60 to 64% for digestible dry matter, 70 to 73% for caloric intake, and 70 to 87% for radiocesium. Body equilibrium concentrations and biological half-lives of radiocesium in each species permitted estimates of food consumption comparable to gravimetric determinations. Food intake varied between different species and ranged from 1.5 to 3.5% of dry body weight per day. Bomb calorimetry and respirometry measurements were used to partition the total energy budgets. Caloric inputs required for maintenance, production, and growth were determined. Radiocesium elimination rates were correlated with the metabolic rates of individual species, and radionuclide turnover rates in tagged individuals were demonstrated to be a practicable means of determining the activity and metabolism of species in their natural habitats. (BBB)

6760 ACTION OF WHOLE-BODY IRRADIATION ON THE METABOLISM OF TRIIODOTHYRONINE-^{131}I. Grigoresco, St.; Nedelco, C.; Nastase, M. (Center of Radiobiology and Molecular Biology, Bucharest). Rev. Roum. Endocrinol., 4: 41-9(1967). (In French).

The metabolism and body distribution of triiodothyronine (T_3) labeled with ^{131}I were studied in dogs and in mice irradiated with whole-body doses of x rays. Experiments were conducted on the distribution of $T_3-^{131}I$ in the normal dog, and on the distribution of $T_3-^{131}I$ in the irradiated mouse. Twenty dogs and 30 mice were used. The $T_3-^{131}I$ was administered intravenously to dogs and intraperitoneally to mice. X-ray doses of 400 R for dogs and 500 R for mice were delivered at 180 KV at a dose rate of 19.5 R/min. Whole-body irradiation of mice immediately after administration of $T_3-^{131}I$ resulted in more rapid incorporation of the labeled hormone in various tissues. When administered three hr after whole-body irradiation of dogs, $T_3-^{131}I$ disappeared more quickly from the blood and the blood level of the hormone remained high if administered 48 hr after irradiation. Results suggested that the action of $T_3-^{131}I$ can reflect variation in metabolic level of tissue when stimulated by irradiation. (BBB)

6761 THE IMPORTANCE OF DECALCIFICATION IN THE TREATMENT OF TUBERCULOSIS. II. UPTAKE OF ^{45}Ca BY TUBERCULOUS ORGANS OF GUINEA PIGS. Jelonek, A. (Academy of Medicine, Krakow). Pathol. Microbiol., 30: 201-7(1967).

Results previously reported indicated that more ^{45}Ca accumulates in the organs of tuberculous guinea pigs than in healthy animals. However, the investigator did not take into account the stages of development of the pathologic process in different animals or the corresponding histopathologic changes which were the subject of the experiments reported here. Guinea pigs were infected with Mycobacterium tuberculosis ($H_{37}Rv$) and were killed four or eight weeks after inoculation. Forty-eight hr before death, the animals were injected intraperitoneally with 0.11 μCi of ^{45}Ca per g body weight. At autopsy, the lesions were evaluated macroscopically, and radioactivity was determined in the lungs, liver, spleen, and kidneys. Four weeks after infection marked differences in the advancement and extent of the pathologic lesions were observed in the animals. The differences were correlated with the ^{45}Ca uptake, as shown by the high standard deviation of uptake in different organs. Similarly, eight weeks after infection less extensive lesions were accompanied by smaller scatter of ^{45}Ca uptake. Although caseous necrosis was absent in most of the organs four weeks after infection, more ^{45}Ca accumulated in the organs than in those of healthy guinea pigs. Eight weeks after infection, the amount of ^{45}Ca uptake was proportional to the number of foci of caseous necrosis. Eight weeks after infection the kidneys exhibited high radioactivity, presumably due to loss of ^{45}Ca by this route. Evidently decalcification of the body in tuberculosis is accompanied by a tendency to hypercalcification of organs with tuberculous lesions through mobilization of the Ca in the bones, part of which is excreted. (BBB)

6762 THE EFFECT OF PREPLANTING SEED TREATMENT BY γ RAYS ON THE OXIDATIVE PHOSPHORYLATION IN COTTON LEAVES. Arslanova, S. B.; Atakuzieva, R. A. Uzb. Biol. Zh., No. 3, 11-13(1967). (In Russian).

Irradiation of dry cotton seeds by γ rays decreases oxygen adsorption by leaves, but bonding of inorganic phosphorus remains almost at the control level. Decrease of O_2 adsorption reduces the possibility of the oxidation of a definite quantity of organic substances in an organism. On this account the possibility of inorganic phosphorus utilization for synthesis of macroergic compounds stimulated the phosphorylation process. As a result of the intensity of metabolism the increase of unginned cotton yields were increased by 10 to 11 percent. (auth)

6763 INACTIVATION OF DRY RIBONUCLEASE BY IONIZING RADIATION. I. SEARCH FOR THE BREAKAGE OF SULFUR BRIDGES. Ray, Dilip K.; Hutchinson, Franklin (Yale Univ., New Haven). Biochim. Biophys. Acta, 147: 347-56(Oct. 23, 1967). (NYO-2653-31).

The destruction of S–S bonds by ionizing radiations was looked for in the enzyme ribonuclease irradiated in the dry state. Two different methods showed negligible loss at doses such that more than 60% of the enzymic activity is destroyed. It is concluded that under the conditions of these experiments, loss of enzymic activity is not caused by opening of the sulfur bridges. (auth)

6764 THE ABSORPTION AND TRANSFER OF Sr AND Ca IN VARIOUS PLANTS: ABSORPTION AND DISTRIBUTION OF Sr IN PLANTS. VI. Sakaguchi, Khoshi (Miyazaki Univ., Japan). Nippon Dojo-Hiryogaku Zasshi, 35: 206-9(June 1964). (In Japanese).

The absorption and distribution of Sr in various plants were compared with those of Ca. Various plants and vegetables, including cucumber, barley, corn, and radish, were cultivated in Ca-free solution. The five-day-old plants were removed from the cultures, and 2g samples of the roots were soaked in solutions containing 4 μCi ^{89}Sr and 12 μCi ^{45}Ca 100 ml for 22 hr; roots were dried and the ^{89}Sr and ^{45}Ca assayed. Radioactivity uptake was highest in cucumber (^{89}Sr 9.49 and ^{45}Ca 16.03 cpm $\times 10^3$/g dry wt) and decreased in radish, corn, and barley (^{89}Sr 0.89 and ^{45}Ca 1.73). The discrimination factor of ^{89}Sr absorption to that of ^{45}Ca was 1.05 to 1.68. No plant showed a high specific absorption of ^{89}Sr. Maximum absorption of ^{89}Sr and ^{45}Ca was observed in solutions of pH 7. There was no significant difference in absorption of these two elements. The absorption of ^{89}Sr and ^{45}Ca through the leaves and their distribution were also studied by autoradiography. In this experiment, legumes were cultivated for 20 days and the second set of leaves was soaked in 1 ml of 2 μCi/100 ml ^{89}Sr and 1 ml of 3 μCi/100 ml ^{45}Ca solutions for six days. The autoradiographs showed that ^{89}Sr and ^{45}Ca were absorbed into the soaked leaves. However, there was no transfer of radioactivity to the other leaves. No significant difference in the absorption of these two elements by leguminous plants was observed. (BBB)

6765 COBALT REQUIREMENT FOR NON-NODULATED LEGUMES AND FOR WHEAT. Wilson, S. B.; Nicholas, D. J. D. (Waite Agricultural Research Inst., Glen Osmond, South Australia). Phytochemistry, 6: 1057-66(Aug. 1967).

Metabolism of ^{60}Co, as $^{60}CoCl_2$, and ^{60}Co-cyanocobalamin, in clover and wheat was studied. Cobalt deficiency was produced in nonnodulated subterranean clover, Trifolium subterraneum, grown with nitrate or urea nitrogen, and in wheat, Triticum durum, supplied with nitrate nitrogen. Deficiency effects were also obtained in sterile cultures of T. subterraneum utilizing either cobaltous sulfate or cyanocobalamin as a source of the micro nutrient. Cobamides were not detected in sterile T. subterraneum that rapidly degraded added ^{60}Co-cyanocobalamin. It was shown by gel filtration techniques, that over 90% of the ^{60}Co was not associated with cobalamin or inorganic Co. The separation of these ^{60}Co complexes of low molecular weight from plant extracts as well as radioassay techniques are described in detail. (BBB)

6766 USE OF LABELED ELEMENTS IN AGRONOMY. Delas, J. (Recherches Station d'Agronomie CRASO, Pont-de-la-Maye, France). 9p. (In French). (CONF-650122-1). DTIE.

From Symposium on Nuclear Science, Bordeaux.

The use of labeled elements in the areas of soil science and plant nutrition is illustrated by a review of some recent studies. The foliary pulverization of nutritive elements was followed in beans using ^{32}P and ^{54}Mn as tracer isotopes. The results showed that the physiological age of the leaf and the placing of the leaf to which the radioisotope was applied were very important with respect to the absorption and transport in the plant. The absorption of ^{32}P is significant, but that of ^{54}Mn is low. No antagonism between a high P reserve in the soil and ^{32}P absorption by the leaf was observed. The nitrogen balance in the soil was studied using ^{15}N. The results led to the conclusion that in the soils studied the losses in mineral nitrogen of the fertilizer are low aside from leaching. Isotopic dilution was used to study the phosphorus of the soil. The results showed that the mobility or activity of the phosphate ions of the soil, that condition their absorption by plants, can be evaluated by isotopic dilution velocity measurements. The copper incorporated in the soil was determined by the isotopic dilution method. It was shown that a large part of the copper accumulated in the soil remains in a diffusible form. The activity of the ions therefore increases continuously with the quantities retained. (J.S.R.)

6767 CURRENT PERSPECTIVES IN CANCER THERAPY. Blakemore, William S.; Ravdin, I. S. (eds.). New York, Harper and Row, Publishers, 1966. 246p. $8.50.

The etiology, diagnosis, and therapy of cancer are discussed by 32 authors. Emphasis is placed on current theories on the role of viruses, genetic factors, environmental factors, geographic factors, immunologic factors, and somatic mutations in the induction of neoplasms. Results of recent studies using cell cultures and models of tumor growth are reported. Diagnostic procedures are described. The effectiveness of chemotherapy, hormone therapy, and various combinations of therapeutic agents in the treatment of neoplasms is discussed. A separate abstract was prepared for one paper. (C.H.)

For an abstract of the individual chapters see: 6846.

6768 ANALYSIS AND METABOLISM OF RADIOSTRONTIUM. Ansari, Mohammed Nurul Ali. College Station, Tex., Texas A and M University, 1966. 68p.

Thesis.

A simple and sensitive method for determination of ^{89}Sr was developed. The method consists of ashing the sample in a muffle furnace, dissolving the ash in a minimum amount of HCl, preparing solid samples on glass fiber discs, and determining the activity by liquid scintillation counting. Counting efficiencies of approximately 65% were obtained. The use of glass fiber discs has reduced the error in pipetting and has eliminated quenching. The procedure has given reproducible results and was used successfully for quantitative analysis of ^{89}Sr in various tissues, bones and eggs (shell, yolk and albumin) from birds injected intramuscularly with $^{89}SrCl_2$. An improved and relatively accurate method for the determination of quenching, based on an internal standard, is also described. A program was written for the IBM 7094 Computer that will calculate the absolute activity of β emitters when used as tracers in biological studies involving liquid scintillation spectroscopy. The isotope used as an example for data calculation was ^{89}Sr. The program provided for rapid calculation of large amounts of data in extremely short periods of time. Decay, background, quenching and dilution factors were all taken into account by the program. Precision and counting statistics were also provided in output data. In addition, specific activity of any sample may be determined and any or all data can be retrieved in any desired sequence. Distribution and excretion pattern of ^{89}Sr in the laying hen was studied. When ^{89}Sr was injected into laying hens, about 60 percent was excreted in eggs and feces within five days. The remaining was excreted very slowly. A statistical method was developed for determination of biological half-life of ^{89}Sr in the laying

hen. The biological half-life of ^{85}Sr in the laying hen was between 115 to 130 days. The distribution of ^{85}Sr among egg components was about 92 percent shell, five percent yolk, and three percent albumen. This ratio remained constant all the way from first post injection day to 25th post injection day. Turnover of ^{85}Sr in different bones of the laying hen was variable, and was in the following decreasing order; ribs, sternum, femur, synsacrum, vertebrae, humerus, tibiotarsus, mandible, skull, metatarsi, and toe digits. Bones with plenty of blood supply and bones that were soft and spongy had a higher turnover rate compared to bones that were more compact and had less blood supply as in metatarsi, and toe digits. Ca and Sr ion distribution in the blood serum of laying hens was studied using Sephadex G-25 column chromatography. Sr was completely unbound and Ca was 35 percent bound to serum proteins. This difference in binding with serum proteins partly explains the preferential excretion of Sr over Ca by the kidney. (auth)

Ecology

Refer also to abstracts 6795 and 6817.

6769 (NYO-2579-17) RADIOECOLOGY OF SMALL VERTEBRATE SPECIES UNDER NATURAL ENVIRONMENTS. Progress Report, December 1, 1966–November 30, 1967. (Pittsburg Univ., Pa. Pymatuning Lab. of Ecology). Contract AT(30-1)-2579. 28p. Dep. CFSTI.

The ecology of northern pocket gophers, eastern chipmunk, and uinta ground squirrel was investigated to determine their suitability for experimental research on populations under natural conditions. Owing to the territoriality of these three species, it was possible to use a live trap, mark, and recapture technique to study them. Individuals were observed throughout their life span, and data collected on their growth, morphometry, relative physiological rates, fecundity, and activities. At the same time information was gathered on environmental factors; combined data were placed in a computer information retrieval system for variety in organization and analysis. Physiological data were concerned with ^{131}I retention and release rates. It was found that thyroid activity decreased with increased altitude among the ground squirrel and pocket gopher populations. In chipmunks, sexual and seasonal variations showed up in thyroid activity. Hematological data were collected for chipmunks in their natural habitats for a six month period. Leukocyte counts and blood protein patterns in males were uniform, increasing slightly with the onset of hibernation, while values in females fluctuated with pregnancy and lactation. Studies of irradiated groups showed marked decreases in leukocyte count and protein patterns, varying in duration (but not intensity) with dose. Sub-lethal γ irradiation studies were conducted under natural conditions on individuals and populations of pocket gophers and chipmunks using a portable ^{137}Cs source. Gross populations varied only slightly, but an increase was observed in the rate of turnover within the adult populations. The most pronounced external effect of γ radiation was a deficiency of pigmentation in new hair observed following the first post-irradiation molt. Increased turnover rates within the adult populations may be a reflection of increased predation on the gray animals. (E.R.B.)

6770 (NYO-3273-9) RADIOCHEMICAL AND RADIOECOLOGICAL STUDIES ON BRAZILIAN AREAS OF HIGH NATURAL RADIATION. Annual Report. Penna Franca, Eduardo (Brazil Univ., Rio de Janeiro. Instituto de Biofisica). Oct. 31, 1967. Contract AT(30-1)-3273. 125p. Dep. CFSTI.

Studies were conducted in three Brazilian areas of high natural radioactivity: Guarapary–Meaipe in the monazite sand region, Araxa, and Morro do Ferro, both located in areas of volcanic intrusives. Body burdens of ^{228}Ra and ^{226}Ra were estimated in selected individuals receiving known doses of external radiation within the range of 0.5 to 2.0 rad/yr in the monazite sand area. The frequency of somatic chromosome aberrations was estimated in selected individuals with higher than normal radium and thorium body burdens in the Araxa area. Radioecological studies are being conducted at Morro do Ferro. (H.L.W.)

6771 (NYO-3554-6) EFFECTS OF RADIATION ON MIGRATORY ORIENTATION OF SALAMANDERS. Progress Report, November 16, 1966–November 15, 1967. Shoop, C. Robert (Wellesley Coll., Mass. Dept. of Biological Sciences). Contract AT(30-1)-3554. 11p. Dep. CFSTI.

Progress is reported on the following studies: breeding migration orientation, population ecology, courtship behavior, and sensory perception; development and testing of radiation exposure methods; and effects of field irradiation effects on orientation of migrating salamanders. (H.L.W.)

6772 (ORNL-4168, pp 61-118) RADIATION ECOLOGY. Auerbach, S. I. (Oak Ridge National Lab., Tenn.).

Progress is reported on studies of: the effects of γ radiation on the blood cell count of wild mice and rats; the metabolism of ^{134}Cs and ^{59}Fe in wild mice and rats; the effects of radioactive contamination of water on the fecundity of fish; the effects of γ radiation on the survival of Drosophila populations; the distribution of ^{137}Cs, ^{60}Co, and ^{106}Ru in arthropod food chains in White Oak Lake; the radiosensitivity of various forest tree species of fast neutrons; the dosimetry of γ and fast neutrons in forest trees; the genetic effects of internally-deposited ^{32}P in Tradescantia; the effects of internally-deposited ^{137}Cs on seed germination and production in poplar trees; the effects of fast neutrons on the growth, morphology, and uptake of ^{137}Cs and ^{60}Co by Elodea; the distribution of ^{137}Cs in food chains in forest ecosystems; the distribution of stable Cs, K, and Na in food chains in forest ecosystems; the effects of body size on the metabolic rate of arthropods and insects; the metabolism of ^{134}Cs and ^{42}K in crickets; the effects of body-size and temperature on the metabolism of ^{134}Cs in spiders; the metabolism of ^{187}W in crickets and milkweed bugs; the distribution of ^{45}Ca in dogwood trees, leaf litter, and adjacent soil; the effects of γ radiation on secondary succession in a tropical rain forest; the distribution of ^{137}Cs in a mesic forest after foliar application on understory species; metabolism of ^{85}Sr in bluegill fish; metabolism of Cs and K in fish in the Clinch River and White Oak Lake; the effects of exposure to chronic, low-level radiation in contaminated water on reproduction of carps; the content of ^{137}Cs, ^{60}Co, ^{106}Ru, and ^{65}Zn in algae in White Oak Lake and subsequent effects on growth; the ecology of invertebrates in a constant-temperature spring; the effects of dissolved and suspended materials on biotic productivity in Walker Branch (Tenn.) and the middle Oconee River (Ga.); and the transfer of solar and thermal energy in forest ecosystems. (C.H.)

6773 (ORO-3238-3) FIELD EXPERIMENTS ON THE FLUX OF RADIONUCLIDES THROUGH A SALT-MARSH ECOSYSTEM. Progress Report. Pomeroy, L. R.; Odum, E. P. (Georgia Univ., Athens). Sept. 28, 1967. Contract AT(40-1)-3238. 4p. Dep. CFSTI.

PHOSPHORUS-32—transport through salt-marsh ecosystem
ZINC-65—transport through salt-marsh ecosystem
ECOSYSTEMS—radioisotope transport through salt-marsh, phosphorus-32 and zinc-65 tracer study of
FOOD CHAINS—radioisotope transport through, phosphorus-32 and zinc-65 tracer study of (E.R.B.)

6774 (UCD-34P104-8) ^{90}Sr AND ^{137}Cs FOOD CHAIN RELATIONSHIPS TO DEER AND SHEEP. IV. FACTORS INFLUENCING RADIONUCLIDE ACCUMULATION. Progress Report, June 15, 1966–June 15, 1967. Longhurst, William M.; Kepner, Richard E. (California Univ., Davis). Contract AT(11-1)-34. 49p. Dep. CFSTI.

Progress is reported on: the relation between palatability of forage plants and their volatile compounds; inhibition of microorganisms in the rumen by various essential oils isolated from unpalatable plant species; the influence of essential oil supplementation upon ruminant feed selectivity and voluntary consumption; the influence of urea, urea plus volatile fatty acids, urea plus caproic acid, and casein supplementation upon voluntary consumption of low quality dried range grass by sheep; the influence of impairment of the sensory system on feed selectivity and voluntary consumption in sheep; translocation of ^{47}Ca, ^{137}Cs, ^{131}I, and ^{85}Sr from simulated endogenous sources by the rumen; blood types of deer and sheep as indicators of genetic variability; ^{90}Sr levels in bones of yearling deer; comparison of body water and body water turnover in sheep and deer; and ^{85}Sr accumulation in plants. (H.L.W.)

6775 AN ECOSYSTEMATIC STUDY OF THE FAUNA AND FLORA OF THE SAVANNAH RIVER. Patrick, Ruth; Cairns, John Jr.; Roback, Selwyn S. (Academy of Natural Sciences, Philadelphia). Proc. Acad. Natur. Sci. Philadelphia, 118: 109-407(1966). (NYO-2991-2).

Results are presented from a systematic study of communities of aquatic ecosystems in the Savannah River in the vicinity of the Savannah River plant. The studies were designed to detect changes in the fauna and flora caused by operation of the plant. (C.H.)

6776 ECOLOGICAL CHANGES IN THE INSECT COMMUNITY OF A PITCH PINE–OAK FOREST SUBJECTED TO CHRONIC GAMMA IRRADIATION. Brower, John Harold. Amherst, Mass., University of Massachusetts, 1965. 218p.

Thesis.

A project was established in 1961 at Brookhaven National Laboratory to study the effects of chronic gamma radiation on the insect fauna of a natural forest community. The area of pitch pine-oak-blueberry was irradiated for 20 hours each day with a 9,500 curie ^{137}Cs source. A sweep sampling technique was employed to give reliable samples of the shrub insects. A numerical survey was made to determine the density and distribution pattern of an

aphid on white oak leaves along a decreasing radiation gradient. Pines were checked monthly to determine the intensity of bark beetle infestation. Later, squares of the bark were removed and the developmental success was determined by estimating the per cent of cambial surface utilized. Trap logs were also used to provide Ips populations at very high radiation intensities. Radiation had extensive effects on the vegetation of the experimental forest. Pitch pines were the most sensitive and died within 75 meters of the source. White oaks were more resistant and died to about 60 meters while the ericaceous shrubs were killed entirely at 33 meters. The abundance of the shrub insects was greatly depleted near the radiation source in the area of severe shrub damage. Omitting Psocoptera, insect abundance was 5% of normal at 10m. Normal abundance for most species was reached at about 60m. Near the source the leaf feeding species and their parasites and predators were mostly absent; the insects present were fungivorous or forms with ample vagility to move through the area. The fungivorous Psocoptera were normal or above normal in abundance in the area of complete shrub mortality. In 1963 a species of aphid, Myzocallis discolor, was observed on the radiation damaged white oaks. This aphid was not found in the unaffected forest but increased in abundance on the debilitated oaks to over 25 winged aphids per leaf. This increase amounted to as much as 350,000 aphids per square meter of forest floor area. A possible increase in the soluble amino acid content in damaged leaves was a likely causal factor for the aphid increase. Bark beetles attacked dead and dying trees and the area of infestation increased as pines further from the source died. Trees at high radiation levels were attacked by Ips where the exposure level proved lethal. Several zones of effect on Ips developmental success were recognized at different intensities of exposure. Developmental success was greater on the selfshielded side than on the exposed side of trees. Trap logs were used for studies of developmental success at high radiation intensities. In 1962 development in them was subnormal reaching about 60%. In 1963 total utilization at low radiation intensities approached 100%. The zones of effect were comparable to those in the standing trees. The percent of cambial surface utilized by Ips increased from 9% at 2,300R/day to about 80% at 300R/day. The difference between sides of the same log was as great as 30% because of the shielding factor. Ants are the only insects reported to have a radiation avoidance response. The habits of a colony of Formica integra changed so that ants were no longer exposed to high radiation levels. The ants constructed a 12.5 meter sunken runway from the nest away from the radiation source and they no longer appeared on the exposed nest snag. The insect community in the irradiated area was divided into two parts on the basis of food requirements, one ecologically sensitive and the other ecologically resistant. The former was composed of herbivorous populations and their parasites and predators while the latter contained fungivorous, xylophagous, and saprophagous populations, insects favoring debilitated plants, and the parasites and predators of these groups. (auth) (Disser. Abstr.)

Genetics and Cytogenetics

6777 (ORO-3348-4) GENOME RELATIONSHIPS IN HIBISCUS SECTION FURCARIA. Menzel, Margaret Y.; Wilson, F. D. (Florida State Univ., Tallahassee. Dept. of Biological Science. Texas Agricultural and Mechanical Univ., College Station. Dept. of Soil and Crop Sciences). Dec. 1, 1967. Contract AT(40-1)-3348. 15p. Dep. CFSTI.

Eighteen species of the section Furcaria of the genus Hibiscus were studied for the purpose of establishing genetic and evolutionary relations and comparing tropical plants with more thoroughly understood temperate species. Patterns of genetic differentiation were compared with those of Gossypium. (H.L.W.)

6778 (ORNL-tr-1817) KINETIC ORGANIZATION OF LEPIDOPTERA CHROMOSOMES. Bauer, Hans. Translated for Oak Ridge National Lab., Tenn., from Chromosoma, 22: 101-25 (1967). 33p. Dep. CFSTI. JCL $3.60 fs, $1.19 mf.

In monokinetic chromosomes half of the recombinations from reciprocal translocation are expected to be lethal owing to the formation of bikinetic and akinetic chromosomes. In holokinetic chromosomes all reciprocal recombinations should be viable, because all again are holokinetic. This difference can be used as a tool other than the study of fragment behaviour to decide which type of chromosome is present in an animal species. Pieris brassicae males x-rayed with 6,000 R units and mated to normal females gave in F_1 only 19.9% lethal zygotes (14.7% of these dying late) as compared to a control mortality of about 7.7%. Among the hatched male caterpillars cytologically tested in the last larval instar 64.9% contained in their spermatocytes one to four heterozygous translocation rings or chains consisting of from four to 14 chromosomes. Translocations of similar frequency and even greater complexity were observed in preliminary experiments on Philosamia cynthia. The discrepancy between these results and those on species with monokinetic chromosomes (Drosophila, Phryne etc.) where very high zygotic lethality is observed at comparable Röntgen doses is proof of the holokinetic nature of Pieris and Philosamia chromosomes. Together with earlier results on Bombyx mori by Astaurow and Frolowa and the cytogenetic studies especially by Seiler sufficient proof exists to conclude that all Lepidoptera have holokinetic chromosomes. A survey of the known groups of organisms with chromosomes of this type leads to the assumption that holokinetic chromosomes must be derived from monokinetic ones. The problems connected with this change in kinetic organization of chromosomes are discussed. (auth)

6779 INDUCED MUTANTS IN TOMATO CULTIVARS. Soressi, G. P. (Istituto di Allevamento Vegetale, Bologna); Cravedi, P.; Marchesi, G. Genet. Agr., 20: 204-19(Dec. 30, 1966). (In Italian).

In X_2 and M_2 generations bred respectively from x ray and EMS treated seeds, many morphological or physiological mutants were detected. Those suitable for studying theoretical problems or with some value in plant breeding, are described. (auth)

6780 REPRODUCTIVE DEATH OF IRRADIATED CULTURED CELLS AND ITS RELATION TO MITOSIS. Watanabe, I.; Okada, S. (Univ. of Rochester, N. Y.). Contract W-7401-eng-49. Nature (London), 216: 380-1(Oct. 28, 1967). (UR-49-828).

A close relationship between mitosis and cell death has been demonstrated in rat retina, and similar observations have been made on various other cell systems. This type of death has been called "reproductive death," stressing loss of reproductive integrity. Evidence suggesting a close relationship between mitosis and cell death can be divided into three classes: (a) the radiation dose needed to kill cells at and after the first post-irradiation mitosis is, in most rapidly dividing cells, substantially less than needed for interphase death; (b) the appearance of dead cells is associated with the appearance of mitotic cells; (c) it was found that the conditions which modified the mitotic index of the cell population affected the appearance of dead cells in the tadpole. This communication provides further evidence that the post-irradiation mitotic peak is positively related to reproductive death of mouse leukaemic cells, L.5178Y, in culture. The observations agree with the idea of chromosome aberrations being the principal cause of reproductive death in cultured mammalian cells. (U.K.)

6781 FURTHER EXPERIMENTS ON THE USE OF X-RAYS AND OTHER METHODS IN INVESTIGATING POTATO CHIMERAS. Howard, H. W. (Plant Breeding Inst., Cambridge, Eng.). Radiat. Bot., 7: 389-99(Oct. 1967).

At the shoot apex in potatoes (Solanum tuberosum L.) three layers, L_1, L_2 and L_3, can be distinguished. Mutations producing bud-sports may occur in either one or more of these three layers. Determination in the periclinal chimeras of which layer or layers are normal or mutant can be made by breeding behavior, eye-excision of tubers, artificial induction of root buds, and x-ray treatment. Breeding behavior is the best method for determining the constitution of L_2 and eye-excision the constitution of L_3. Where both L_2 and L_3 are mutant, the constitution of L_1 can often be shown to be normal by x-ray treatment. The x-ray treatment used was 3500 R given to apical ends of tubers with small sprouts. The bud-sports investigated were all mutations for changes in leaf shape (entire leaf, ivy leaf, holly leaf, wilding and feathery wilding) or for changed photoperiodic reaction (bolter). Entire leaf, ivy leaf, some wildings and feathery wilding all had mutant L_2 and L_3 but normal L_1. Other wildings, holly leaf and a bolter all probably had L_2 mutant and L_3 normal. In such cases it is not possible to determine the constitution of L_1 by x-ray treatment. Leaf shape in potatoes is mainly determined by the constitution of L_2 but L_1 and probably L_3 may have minor effects on leaf shape. There is a strong tendency for chimeras with L_1 normal, L_2 mutant and L_3 normal to change to L_1 normal, L_2 mutant and L_3 mutant. (auth) (UK)

6782 PRODUCTION AND CHARACTERIZATION OF ULTRAVIOLET INDUCED MUTATIONS IN ASPERGILLUS NIGER. Das, Arati; Nandi, P. (Bose Inst., Calcutta). Trans. Bose Res. Inst. (Calcutta), 28: 83-91(Sept. 1965).

Aspergillus niger strain C was subjected to uv irradiation at the dose level 0 to 19.2×10^4 ergs/mm^2/sec., for which exposure time was 0 to 32 minutes. The percentages of survival and mutation were determined. The frequency of mutation increased with the increasing dosages of radiation up to 7.2×10^4 ergs/mm^2/sec. The mutation frequency, however, decreased with further increase in the dosage of uv radiation. The strains isolated were grouped as

morphological and physiological mutants. In the former case four colonial types were characterized, while in the latter there were nine subgroups with isolates having varying citric acid producing capacity. The specific morphological characters were correlated with the citric acid producing capacity of the mutants. The non-spore forming cultures were found to be generally associated with higher yield of citric acid. Of the five selected strains tested, three remained stable. The maximum acid titre was attained in one mutant strain, CU 2020, showing 1.8 times (53.8 mg. of citric acid per ml.) increase in acid production over the parent one. (auth)

6783 TOBACCO MUTANTS OBTAINED BY GAMMA-RADIATION OF EARLY DEVELOPMENTAL STAGES. Saccardo, F. (CNEN, Rome); Devreux, M. Genet. Agr., 20: 202-3(Dec. 30, 1966). (In Italian).

Gametes, zygotes and proembryos of Nicotiana tabacum var. purpurea were irradiated with ^{60}Co γ ray exposures of 1, 2, and 4 kR. Fifteen mutant lines, isolated from these treatments, are described. The majority of the mutants show reduction in height, narrow leaves, and changes in several floral characters, namely: color, calix size, length of corolline tube, length of stamens and pistils, and corolla width. Cytogenetic analysis reveals the presence in the apical meristems of several mutants (still in the fourth generation after irradiation), of double bridges, that can be explained by the transmission of dicentric chromosomes; multivalents were also found in the P.M.C. of some mutant lines, accompanied by a reduced pollen fertility. These structural abnormalities can evidently be tolerated because of the polyploidy of N. tabacum. (auth)

6784 CORRELATION BETWEEN TRAITS OF TRIFOLIUM REPENS VAR. GIGANTEUM. Palenzona, D. L.; Ferrari, A. (Univ., Padua, Stazione Sperimentale di Praticoltura, Lodi, Italy). Genet. Agr., 20: 307-12(Dec. 30, 1966). (In Italian).

Seeds of Trifolium repens cv. giganteum (clover) were irradiated with different doses of x rays. Data were collected in the R_1 and R_2 generations on the length and width of the leaflets and the number of fluorescences per plant. Correlations between those traits were analyzed in each generation with the aim of detecting mutagenic effects of ionizing radiations. In the R_1 we found a decrease in the values of the correlation coefficients following x irradiation. In the R_2 there was a decrease only at the higher dose (40,000 R). It is expected that correlation should decrease as a consequence of the newly induced variability. The discrepancies between R_1 and R_2 should be attributable to non-additive interaction effects. (auth)

6785 GENETIC VARIABILITY OF LUCERNE AFTER X-RAY TREATMENT OF SEEDS. OBSERVATIONS ON THE R_1 GENERATION. Scossiroli, R. E.; Sarti, A. (Univ., Bologna, CNR, Lodi, Italy). Genet. Agr., 20: 322-39(Dec. 30, 1966). (In Italian).

X-ray treatments were applied to seeds of Florida and Cremonese lucerne varieties. Part of the irradiated and also of non-irradiated seeds were further treated with water at 60°C for one minute. Using the method of clonal subdivision a study was performed with the goal of estimating changes in the genetic component of phenotypic variation for several quantitative traits. It was found that in the R_1 generation the x-ray treatments induced in general an increase in the amount of genetic variation estimated from a hierarchic model of analysis of variance. The increase in genetic variation was found to be non-linearly proportional to the dose of x rays applied to the seeds. The heat shock resulted in some benefit in germination in the irradiated and in the non-irradiated seeds and also in some increase in the estimate of genetic variation. (auth)

6786 RADIATION-INDUCED REORIENTATION OF CHROMOSOME REPLICATION SEQUENCE: GENERALITY IN ESCHERICHIA COLI; INDEPENDENCE OF PROPHAGE OR 5-BROMOURACIL TOXICITY. Hewitt, R.; Billen, D.; Jorgensen, G. (Univ. of Texas, Houston. Anderson Hospital and Tumor Inst., Houston, Texas). Contract AT(40-1)-3596. Radiat. Res., 32: 214-26(1967). (ORO-3596-5).

The authors' previous observation that irradiation with x-rays or ultraviolet light induces an altered chromosome replication sequence in Escherichia coli strain 15T⁻(555-7) was extended to additional strains, B/r and C. Since strains B/r and C showed no evidence of inducible prophage when examined by the same procedures that previously showed strain 15T⁻(555-7) to be lysogenic, we conclude that postirradiation alteration of chromosome replication sequence is not related to induction of prophage by radiation. The accuracy of measuring replication sequence by 5-bromouracil density labeling was determined by experiments in which density labeling was accomplished with ^{13}C and ^{15}N. An inhibitory effect of 5-bromouracil on DNA synthesis was observed to a variable extent in the strains studied. Postirradiation inhibition of the rate and extent of total DNA replication by 5-bromouracil also varied according to strain, but the replication sequence observed after irradiation was shown to be accurately measured by 5-bromouracil density labeling. When studies were performed with strain 15T⁻(555-7) previously density-labeled with ^{13}C and ^{15}N, similar postirradiation replication sequences were obtained in ^{12}C and ^{14}N medium containing either 5-bromouracil or thymine. (auth)

6787 X-RAY INDUCED PHENOTYPIC REVERSIONS IN ARABIDOPSIS. Redei, G. P. (Univ. of Missouri, Columbia). Radiat. Bot., 7: 407-7(1967).

The recessive gene im of Arabidopsis possesses two functionally different states. In one state chloroplast differentiation is apparently normal; in the other state the plastid formation does not proceed beyond a certain early stage. Even under highly uniform environmental conditions variegation results. The transition from one state to the other may be influenced by various chemical and physical agents. Ribonuclease appears to play an important role in the control of the variegation, since the white tissues of the variegated plants display higher than normal ribonuclease activity. Any agents or factors which influence the activity or the synthesis of the enzyme affect the expression of this gene. X-rays tend to normalize the mutant, as estimated by an increase in chlorophyll production. The x-ray effect, though slight, is persistent for several mitotic cell generations. The x-ray induced phenotypic reversion vanished after one meiotic cycle; thus, true genetic reversions do not occur. The two different states of the im gene show resemblances to some features of the episomic elements of bacteria. Since there is no strict definition for episomes in plants, only analogies can be pointed out. (auth)

6788 INDUCED MUTATIONS AFFECTING QUANTITATIVE CHARACTERS IN ATUOTETRAPLOID RYE POPULATIONS. Aastveit, K. (Inst. of Genetics and Plant Breeding, Vollebekk, Norway). Radiat. Bot., 7: 363-8(Oct. 1967).

Seeds of two artificially produced autotetraploid populations of winter rye were treated with neutrons in each of two successive generations. After another generation without treatment and open flowering within populations, a random number of individual plants from untreated and treated populations were progeny tested. The effect of neutron treatment on seed set and strawlength was measured. Treatment led to a significant lowering of the means and a significant increase in the variation of both characters and in both populations. In both characters more extreme progenies than those from untreated populations were obtained in the negative direction only. The parent-offspring correlations, as well as the correlations between the two characters scored, increased in the treated populations as compared with untreated. The data presented for strawlength contradict Brock's hypothesis, which says that random mutations would be expected to shift the mean away from the direction of previous selection. The data are briefly discussed in relation to practical breeding. (auth)

6789 CONCERNING THE MECHANISM OF ULTRAVIOLET MUTAGENESIS. A MICROMANIPULATORY PEDIGREE ANALYSIS IN SCHIZOSACCHAROMYCES POMBE. Haefner, K. (Southwest Center for Advanced Studies, Dallas). Genetics, 57: 169-78 (Sept. 1967).

The pattern of occurrence of uv-induced auxotrophic and slow growth mutations in pedigrees derived from about 1600 individually irradiated phased cells was studied, using micromanipulation. In five out of 23 pedigrees, all fourth-generation branches of the pedigree were mutated (pure mutant clones). Within such pedigrees all branches carry the same homoallelic mutation. In 10 out of those 23 only one half of the progeny is mutated. The data suggest that real pure mutant clones either come from photoproducts affecting both DNA strands simultaneously, or result from single-strand alterations followed by a process copying the change in one strand onto the opposite strand. Several cases were found in which a pure mutant clone occurred from a cell which had only one active first generation descendent. (auth)

6790 RECESSIVE LETHALS IN SECOND CHROMOSOMES OF DROSOPHILA MELANOGASTER WITH RADIATION HISTORIES. Salceda, Victor M. (Rockefeller Univ., New York). Contract AT(30-1)-3096. Genetics, 57: 691-9(Nov. 1967).

Experimental populations with radiation histories, and a control population, were kept in laboratory population cages under conditions of extreme crowding and intense larval competition. The frequencies of second chromosomes that were lethal or semilethal when homozygous remained at levels appreciably higher than in the control, while the egg-to-adult viability declined below the control level in the populations with radiation histories. The rates of allelism of the lethals in experimental populations are fairly high, owing to some lethal loci being present in many chromosomes.

These lethals are maintained in the populations by natural selection because of their heterotic effects in heterozygous individuals. (auth)

6791 LINKAGE GROUP: KARYOTYPE CORRELATION IN THE HOUSE FLY DETERMINED BY CYTOLOGICAL ANALYSIS OF X-RAY INDUCED TRANSLOCATIONS. Wagoner, Dale E. (Agricultural Research Service, Fargo, N. D.). Genetics, 57: 729-39 (Nov. 1967).

Cytological studies of x ray induced translocations in the house fly, Musca domestica L., showed that the five linkage groups previously reported by other workers belong to the five pairs of autosomes also previously reported. No sex-linked mutants were found thus far. The correlation of the linkage groups to particular chromosomes as seen cytologically was not previously attempted and was the objective in this work. The new assignment of linkage groups to particular chromosomes (made by using Perje's numbering of the house fly karyotype with X and Y representing the sex chromosomes and Roman numerals I to V representing the autosomal pairs starting with I as the longest pair and ending with V as the shortest pair) shows the Rl marker and its associated linkage group located on chromosome I, the car marker and its linkage group on chromosome II, the bwb marker and its linkage group on chromosome III, the rb marker and its linkage group on chromosome IV, and the ocra marker and its linkage group on chromosome V. (auth)

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Refer also to abstracts 6354, 6436, 6555, 6591, 6652, 6697, 6731, 6739, 6764, 6835, 6848, 6861, 6866, 6919, 6922, and 7714.

6792 (AED-C-02-07) BIBLIOGRAPHIEN ZUR KERNFORSCHUNG UND KERNTECHNIK. SEKTION 02. KONTAMINATION UND DEKONTAMINATION VON LEBENSMITTELN. (Bibliographies in Nuclear Science and Technology. Section 02. Contamination and Decontamination of Food). Schmidt, H. D.; Beising, K. (comps.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Mar. 1967. 80p. (In German and English). Dep.

Three hundred and one references are presented to conferences, dissertations, patents, reports, journals, and books containing literature on the contamination and decontamination of foods. Author, patent, report, and subject matter indexes are included. (E.R.B.)

6793 (BNWL-564) AIR QUALITY SURVEY AT SELECTED SITES ON THE HANFORD PROJECT. Alkire, G. J.; Wyss, C. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1967. Contract AT(45-1)-1830. 17p. Dep. CFSTI.

The concentration of five potentially significant air pollutants (SO_2, NO, NO_2, HCHO, and H_2S) was measured at selected sites on the Hanford Project during the period May 17, 1967, through July 14, 1967. The observed concentration of these gases was below the detection limit most of the time, but significant levels of nitrogen oxides and sulfur dioxide were observed at some sites part of the time. Downwind of a chemical separations plant, nitrogen oxides (NO + NO_2) were above detection limits (0.01 ppM) about 30% of the time. Peak NO + NO_2 concentrations ranged to 0.36 ppM, and hourly averages ranged to 0.12 ppM. Average sulfur dioxide concentrations were less than or equal to background 96% of the time at two sites, and 89% of the time at a third site. Aldehydes and hydrogen sulfide were not detected above background during the survey. (auth)

6794 (CEA-R-3159) DETERMINATION D'UNE METHODE DE NETTOYAGE ET DE DECONTAMINATION PAR SOLVANT. (Determination of a Cleaning and Decontamination Process Using Solvents). Boutot, Pierre; Schipfer, Pierre (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). Mar. 1967. 17p. (In French). Dep.

Solvents currently used in industry with and without additions were studied with respect to their capacity to clean and decontaminate fabrics contaminated with soluble and insoluble radioisotopes. The wear and the shrinkage of the fabrics treated were also determined. Within the framework of the regeneration of the solvents the possibilities offered by filtration and distillation were also studied. The solvents studied were trichloroethylene, perchloroethylene, white spirit, and trichlorotrifluoroethane. With respect to the dry cleaning and solvent regeneration aboration, the best results were obtained by combined addition of filtrating, absorbant, and detergent agents such as Clarcel, vegetable charcoal, and Lanadol. The decontamination capacity of the solvents varied with the nature of the radioisotope and the degree of humidity. White spirit and trichlorotrifluoroethane gave only mediocre results in cleaning. The decontamination factor was only slightly improved by preliminary acidification or the use of complexing agents. In the regeneration of the solvents by filtration the results were identical in all cases, but in the regeneration by distillation only trichloroethylene and perchloroethylene were adequately generated. (J.S.R.)

6795 (COO-414-6) DETAILED CHARACTERIZATION OF SOIL AND VEGETATION ON SELECTED SITES TO SERVE AS BASIS FOR FUTURE EVALUATION OF EFFECT OF RADIOACTIVE CONTAMINATION. Technical Progress Report, March 1-November 20, 1967. Haghiri, F. (Ohio Agricultural Research and Development Center, Wooster). Contract AT(11-1)-414. 60p. Dep. CFSTI.

RADIOISOTOPES — content occurring in low-level environmental samples, development of two-crystal γ-scintillation spectrometer for determining emissions from
STRONTIUM-90 — complexes with high molecular weight polymers in soil samples; reactions with organic matter in soils; reactions with clay fractions of soils, effects of, on cation uptake by plants, exchange, and leaching; uptake by agronomic crops, effects of liming and soil type on; uptake by vegetable crops, effects of mineral content of soil on; uptake by trees, effects of calcium content of leaf on; retention by soil, effects of soil management systems and vegetation on
YTTRIUM-90 — complexes with high molecular weight polymers in soil samples
FISSION PRODUCTS — gamma emission by, distribution of, on plant and soil samples, use of γ spectrometry to measure low-level; distribution in soils, effects of trees on γ-emitting
SOILS — strontium-90 treatment of, chemical and physical properties
STRONTIUM — movement in soil profile, effects of temperature variations on

6796 (COO-1269-15) GAMMA-RADIATION DETECTION OF WATER CONTENT IN TWO-DIMENSIONAL EVAPORATION PREVENTION EXPERIMENTS. Kirkham, Don; Rolston, D. E.; Fritton, D. D. (Iowa State Univ. of Science and Technology, Ames. Dept. of Agronomy). June 1967. Contract AT(11-1)-1269. 21p. (CONF-670641-1). Dep. CFSTI.

From Symposium on the Use of Isotope and Radiation Techniques in Soil Physics and Irrigation Studies, Istanbul, Turkey.

A ^{137}Cs gamma scintillation detector system (gamma apparatus) was used to measure water content in a two-dimensional soil model. The gamma apparatus was built into a lifting apparatus that accommodates both vertical and horizontal 150 cm long soil columns and 150 × 35 cm two-dimensional soil models. The lifting apparatus was constructed by using a vertical rectangular frame with internal dimensions of 80 cm width and 70 cm height. Lead cubes, 25 cm on a side, containing a 251 mCi ^{137}Cs source and a NaI scintillation detector are offset to one side of the vertical rectangular frame to scan a vertical cylindrical column. The faces of the lead cubes are 24 cm apart and attached to the rectangular frame so that the gamma beam is midway between the base and top. There are no attachment parts that cross the 24 cm gap between the lead cubes, and this leaves a 24 cm wide by 70 cm high space that will allow a two-dimensional model or horizontal column to be moved horizontally through this space. Vertical movement of the gamma apparatus and horizontal movement of the model then allow two-dimensional scanning of a model. To demonstrate the ability of this design for a gamma apparatus to scan two dimensions, a 92 cm long, 30 cm tall, and 10.15 ± 0.05 cm wide model with three equal 30 cm long compartments was used to evaluate potential water conservation. A vertical sand mulch, 2 cm thick, was placed on each side of each compartment, a 3 cm thick sand layer was placed on the bottom, and soil was packed in the rest of the model. The surface treatments were: bare soil, 1 cm soil over 1 cm of sand mulch, and 1 cm of sand mulch. Water contents in two dimensions were determined for 2 cm simulated rainfall applications for the three treatments. When a subsurface sand mulch was used, the mulch acted as a barrier to infiltration. Therefore, the surface sand mulch conserved more water than did the subsurface sand mulch, but both the surface and the subsurface sand mulches conserved water as compared with no sand mulch layers. In addition, soil columns, 6.9 cm in diameter and 33 cm tall, were used to study the effectiveness of various thicknesses of surface sand mulches in preventing evaporation. Thickness of sand mulches did not influence greatly the amount of water conserved if the sand layer was 1 cm or more thick. (auth)

6797 (COO-1422-12) EFFECT ON THE MEASUREMENT OF BONE MINERAL OF ^{126}I CONTAMINATION OF ^{125}I. Judy, Philip; Cameron, John R.; Sorenson, James A. (Wisconsin Univ., Madison. Dept. of Radiology). Aug. 1, 1967. Contract AT(11-1)-1422. 9p. Dep. CFSTI.

Iodine-126 contamination of ^{125}I is the major contribution to the background. This background makes pulse height analysis desirable. With our present spectrometer settings the contribution to the error in bone mineral measurements is 1% at most. While the use of a simpler discriminator would be desirable, the error caused by ^{126}I contamination should be evaluated more carefully. The measurement of bone mineral at the largest window width increased 5% in six weeks. Such an error might be corrected by use of a standard. (auth)

6798 (IAEA–2819–6) DOSIMETRY IN HUMAN RADIOEPIDEMIOLOGY, WITH SPECIAL REFERENCE TO SKELETAL DOSE RATES IN THOROTRAST CASES. Progress Report, March 15, 1966–March 14, 1967. (International Atomic Energy Agency, Vienna (Austria)). Contract AT(30-1)-2819. 7p. Dep. CFSTI.

Progress is reported on the determination of skeletal radiation dose rates in persons injected with Thorotrast. Data are included from studies on the localization of γ-emitting radioisotopes by profile scanning of patients using a scintillation detector with split-lead collimators and a mathematical procedure for converting the observed profile of counting rates along the body to an activity profile. (C.H.)

6799 (LA–3721) NEUTRON ACTIVATION PROBABILITY FOR SODIUM IN MAN. McGuire, S. A. (Los Alamos Scientific Lab., N. Mex.). Sept. 2, 1966. Contract W-7405-eng-36. 6p. Dep. CFSTI.

Knowledge of the neutron activation of blood sodium in man can be used to calculate an accidental-neutron dose if the neutron spectrum and the neutron capture probability of the man as a function of energy are both known. Calculations of the neutron capture probability of a 136-lb man, a 200-lb man, and 30-cm-, 24-cm-, and 18-cm-diameter by 60-cm-high cylinders are described. The capture probability of a man was found to be below that of the 30-cm-diameter cylinder at all energies and much closer to the capture probability of the 18-cm-dia cylinder. Below 0.1 MeV, the capture probability of a 136-lb man averages about 20% lower than that of the 30-cm-diameter cylinder; but above 0.1 MeV, the gap widens rapidly until the capture probability at two MeV is twice as great for the cylinder as for the man. The position of man with respect to the neutron beam was found to have a considerable effect. The capture probability averages about 20% lower for a man standing side-on to the beam than for one facing into it. (auth)

6800 (NP–17015) ANNUAL REPORT FOR THE YEAR 1966. (National Radiation Lab., Christchurch (New Zealand)). 41p. (NRL-AR-17). Dep.

Progress is reported on field services in New Zealand, Sabah, Singapore, and Thailand. Laboratory services include: monitoring of occupational exposure; supply of therapeutic applicators; radiation measurements; licensing; advisory services; education and training; and development of national radiation protection service in Thailand. Fallout monitoring studies include: gamma radiation monitoring on seven islands in the Pacific; measurement of total beta activity in atmosphere and rain water; measurement of ^{90}Sr and ^{89}Sr in milk and rain; ^{90}Sr in bone and soil; ^{137}Cs and ^{131}I in milk; and ^{131}I in cattle thyroid. Research and development activities were concerned with methods for radiochemical analysis, radiation protection planning in diagnostic radiology, testing for leakage of radon, and transferable fraction of radioactive contamination of surfaces. (H.L.W.)

6801 (NYO–3364–37) A STUDY OF COWS' DIET IN NORWAY, 1961–1966. Stroemme, Aksel (Statens Radiologisk-Fysiske Laboratorium, Oslo (Norway)). Contract AT(30-1)-3364. 13p. Dep. CFSTI.

The average composition of cows' food prior to the investigation of the ^{137}Cs concentration in milk and meat is given. From this information it can be seen that there were minor changes in the composition of the food. The percent contribution of hay and grass gradually decreased, whereas concentrate has become a more important item. The use of Beckmann Treated Straw and roots is insignificant in the three northern counties and is compensated by a more extensive use of concentrate. Beckmann Treated Straw is more commonly used in the eastern counties than in the rest of the country instead of silage. The overall picture is very similar in all parts of Norway, and the data show that there are no major differences in the feeding of the cows throughout the country. The concentration of ^{137}Cs in the cows' diet, and thus in meat and milk is a function of the amount of ^{137}Cs in the diet. The imported items contain little or no ^{137}Cs and the per cent contribution to the diet is about the same in all parts of Norway. The rest of the cows' diet is produced in the same districts as it is consumed. Therefore, the great differences in the concentrations of ^{137}Cs in milk as well as in meat are almost solely due to the differences in the local fallout of ^{137}Cs. (auth)

6802 (ORNL–4168) HEALTH PHYSICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING JULY 31, 1967. (Oak Ridge National Lab., Tenn.). Oct. 1967. Contract W-7405-eng-26. 344p. Dep. CFSTI.

Separate abstracts were prepared for all six sections of the report. A list of the 162 articles published during 1967 is presented. (B.H.S.)

For abstracts of individual sections see: 6436, 6652, 6772, 6803, 6804, and 7132.

6803 (ORNL–4168, pp 231–88) INTERNAL DOSIMETRY. Snyder, W. S. (Oak Ridge National Lab., Tenn.).

A three compartment computer program was developed for use in energy calculations for particles emitted by electrons or positrons, electron capture, and internal conversion of γ rays. The ultimate goal is a computer code that uses nuclear decay data for calculating the effective energy per event for the particular organ of interest. A Monte Carlo-type computer code and a human phantom were used to estimate the radiation dose from four initial γ energies in 22 organs and 100 sub-regions when the source was distributed uniformly in the body and skeleton. Using the computer code and phantom the γ dose to man from exposure to an external point source and to the bladder, kidneys, and ovaries from trace amounts of ^{193}Hg- or ^{203}Hg-labeled neohydrin were estimated. The contribution of ^{197}Hg or ^{203}Hg decay to radiation dose was measured as a function of residence time. A computer code was designed for determining Pu body burden in man from excretion data. Results are reported from a long-term study on the uptake and excretion of Ca, Mg, K, Na, P, Al, Ba, Be, B, Cr, Co, Cu, Fe, Mn, Mo, Ni, Ag, Sr, Sn, Ti, V, Zn, and Zr by persons consuming a routine diet. Values obtained over two two-month periods compared very well with the values suggested by the Task Group for Standard man. A chemical preconcentration procedure is described for use in the determination of trace elements in bone tissue. (C.H.)

6804 (ORNL–4168, pp 289–311) HEALTH PHYSICS TECHNOLOGY. Fish, B. R. (Oak Ridge National Lab., Tenn.).

Data are presented from studies on the adhesion of aerosol particles. Equations are included for use in calculating the capillary force between two spheres of equal radii and the effects of electrical forces on particles. A modified design of an exploding-wire aerosol generator is described. Tracer studies on the interactions of I vapor and SO_2 with airborne particles were conducted using the aerosol generator and a sulfur dioxide vapor-handling and calibration system. Data are presented on the removal of SO_2 from an air stream by deposited aerosol particles of 11 elements. Initial retention of particles on skin was studied using small spherical wax particles labeled with a zinc sulfide phosphor. Radiation dose from deposited particles was calculated as a function of time. A series of arc and scan counts on a subject who received an intravenous injection of 570 μCi of ^{197}Hg and about 95 μCi of ^{203}Hg showed the activity to be located in the area of the liver and kidneys. Detection limits of a wound probe were found to be equivalent for a $^{238}PuO_2$ microsphere containing about 82 μCi and 0.01 nCi of ^{239}Pu. A method for ^{90}Sr analysis of samples of bone, foods, vegetation, and water is described. (C.H.)

6805 (ORNL–TM–2040) REMOVAL OF ELEMENTAL RADIOIODINE FROM FLOWING HUMID AIR BY IODIZED CHARCOALS. Adams, R. E.; Ackley, R. D. (Oak Ridge National Lab., Tenn.). Nov. 2, 1967. Contract W-7405-eng-26. 25p. Dep. CFSTI.

Certain types of iodized charcoal were found to be useful for trapping radioactive methyl iodide. The question was raised, however, as to whether or not the iodizing process reduces the capacity of the charcoal for elemental iodine (I_2) to an unacceptable level. Investigation concerning this point was made for the conditions of room temperature and of very high relative humidity, 98 and 100%. In the case of the 100% relative humidity condition, the charcoal was caused to contain bulk phase liquid water, i.e., it was water-logged. The iodized charcoals tested were found to possess ample capacity at 25°C for I_2 when the relative humidity was 98%. The water-logged iodized charcoals exhibited erratic I_2 removal performance, which ranged from good to fair. This somewhat unpredictable behavior is probably associated with sweep gas channeling in the charcoal bed rather than overloading of the charcoal with I_2. Obviously, operational conditions that might result in water-logging should be avoided if efficient trapping of I_2 is required. (auth)

6806 (SCPRI(RM)–IX–1967 and Suppl.) RAPPORT D'ACTIVITE, SEPTEMBRE 1967. (Report of Activities, September 1967). (Service Central de Protection Contre les Rayonnements Ionisants, Le Vesinet (France)). 28p. (In French). Dep.

Radioactivity was monitored in the atmosphere at ground level and at high altitudes, rain water, milk, and vegetables. Tabulations were made of contents of: ^{7}Be, ^{54}Mn, ^{90}Sr, ^{95}Zr, ^{103}Ru, ^{106}Rh, ^{131}I, ^{137}Cs, and ^{140}Ba. Tables also presented for: ^{90}Sr content of

animal bones; ^{131}I content of thyroid glands of cattle; tritium content of water; ^{137}Cs content of fish; and ^{137}Cs and ^{90}Sr content of sea water. A bibliography on radiation protection standards is included. (H.L.W.)

6807 (TRG-Report-1548) EXPERIENCE IN TESTING INSTALLED FISSION PRODUCT TRAPPING PLANT WITH METHYL IODIDE. Hillary, J. J.; Gate, L. F.; Gurney, K. (United Kingdom Atomic Energy Authority, Sellafield (England). Reactor Group). July 18, 1967. 12p. Dep. CFSTI. UK 2s. 6d.

A simple experimental procedure is described, based on labelled methyl iodide, for the full-scale in-site testing of the charcoal bed of an installed fission product trapping plant. A decontamination factor of 1000 is easily measurable for a 10,000 cfm plant with a few mCi ^{131}I. Experience to date on several plants indicated the need for such tests, since the results have in some cases shown inadequate performance, usually associated with mechanical leakage. The most effective method of achieving reliable sealing was found to be to pass gas downwards through a bed of charcoal, which completely filled the available area, rather than to attempt to seal an assembly holding a bed into a flange in the duct or vessel. Provision is necessary for withdrawing representative samples of charcoal for laboratory testing. (auth) (UK)

6808 (AEC-tr-6467/2) LABOR HYGIENE AND INDUSTRIAL SANITATION. A Collection of the Principal Official Publications. Yanin, L. V. (ed.). Translation of Sbornik Vazhneishikh Ofitsial'nykh Materialov po Voprosam Gigieny Truda i Proizvodstvennoi Sanitarii, Gosudarstvennoe Izdatel'stvo Meditsinskoi Literatury, Moscow, 1962. 222p. (IPST-Cat.-1264/2). Dep. CFSTI. JCL $15.00 fs, $6.95 mf.

Thirteen papers are presented; separate abstracts were prepared on three. The remaining 10 papers discuss the control of noise and vibration in industrial installations. (C.H.)

For abstracts of individual papers see: 6809, 6810, and 6835.

6809 (AEC-tr-6467/2 pp 177-94) REGULATIONS FOR THE INSTALLATION AND OPERATION OF X-RAY DEPARTMENTS AND APPARATUSES FOR DEFECTOSCOPY. Translated from Sbornik Vazhneishikh Ofitsial'nykh Materialov po Voprosam Gigieny Truda i Proizvodstvennoi Sanitarii, Gosudarstvennoe Izdatel'stvo Meditsinskoi Literatury, Moscow, 1962.

Regulations for the installation and operation of x-ray equipment for use for diagnostic radiography in the U.S.S.R. are presented. Safety devices for protection against primary and secondary x rays during the operation of mobile and stationary apparatus are described with emphasis on the protection of medical personnel. (C.H.)

6810 (AEC-tr-6467/2 pp 143-76) REGULATIONS FOR TRANSPORTING RADIOACTIVE COMPOUNDS. Translated from Sbornik Vazhneishikh Ofitsial'nykh Materialov po Voprosam Gigieny Truda i Proizvodstvennoi Sanitarii, Gosudarstvennoe Izdatel'stvo Meditsinskoi Literatury, Moscow, 1962.

Regulations governing the transportation of radioactive compounds in the U.S.S.R. are presented. Requirements for the packaging of radioactive compounds for transportation and data on minimum permissible distances between packages containing radioactive compounds and undeveloped photographic, movie, and x-ray films are included. (C.H.)

6811 SAFE LIMITS OF URINARY EXCRETION OF SOME RADIONUCLIDES. Sunta, C. M.; Nambi, K. S. V. (Atomic Energy Establishment, Trombay, India). pp 92-109 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14-18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

Three different approaches were used for calculating the safe limits of urinary excretion of tritium, ^{14}C, ^{22}Na, ^{24}Na, ^{32}P, ^{90}Sr, ^{137}Cs, ^{210}Po, ^{226}Ra, Th, U, and ^{239}Pu. Equations derived for the exponential model approach, the power functional model approach, and elemental distribution approach are outlined and discussed. Results obtained using the three methods are presented in tabular form and with the exception of some cases, there was fair agreement. (B.H.S.)

6812 MAXIMUM PERMISSIBLE CONCENTRATIONS OF FISSION PRODUCT MIXTURES IN AIR AND WATER FOR OCCUPATIONAL EXPOSURE. Iyer, M. Ramakrishna; Krishnamurthy, T. N. (Atomic Energy Establishment, Trombay, India). pp 110-21 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14-18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

In the release of fission products that may arise from the handling of irradiated fuel elements, an assessment of the hazard presented necessitates an estimate of maximum permissible concentrations (MPC) of fission product mixtures in air or water. Eighty-three fission products are taken into account. MPC of the fission product mixture in air decreased with increasing irradiation time as well as with increasing cooling time. For shot times of cooling, MPC of fission products in water was found to increase with irradiation time; the effect was reversed for longer cooling times. The critical organ for fission product mixtures varied with irradiation time as well as with cooling time. (M.C.G.)

6813 INTRALYMPHATIC ^{198}Au PERFUSION IN MALIGNANT DISEASES. Suryanarayan, C. R. (Military Hospital, Delhi). pp 357-9 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14-18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

The facilities and equipment used and the measures taken for radiation protection of medical personnel during ^{198}Au therapy of edema resulting from lymphatic and venous obstruction in patients with advanced malignancies are described. The therapeutic and diagnostic values of intralymphatic ^{198}Au perfusion is discussed. (B.H.S.)

6814 PROPOSED METHOD FOR RADIUM LEAK TESTING BY THE USE OF THE SUPERFLUID PROPERTIES OF HELIUM. Cook, K. J.; Mantel, J. (Wayne State Univ., Detroit). Health Phys., 13: 1233-4(Nov. 1967).

Radium capsules building up gas pressure due to the accumulation of helium from radioactive decay, when subjected to the stresses of handling, may leak radon through undetectable cracks or fissures. Below the "lambda point" (2.18°K) liquid helium becomes a two-fluid model, consisting of normal fluid and superfluid, the latter having a very low viscosity in the range of about 10^{-12} poise. With decrease in temperature below the lambda point an increasing fraction of the normal fluid is transformed into superfluid. A detectable flow of helium occurs through the very fine capillaries of fissures at such low temperatures, a process known as "superleak." Because of the physical properties of liquid helium below the lambda point a cryostat system can be devised for leak testing and decompression of radium containers. Such a system is shown diagrammatically. Helium leaks are detected mass spectrometrically, and such detections would imply that the container is potentially in danger of leaking radon. (UK)

6815 DETERMINATION OF RADIO-IODINE IN AMBULATORY RADIOLOGICAL LABORATORIES. Vodak, Miroslav (Military Inst. of Hygiene, Epidemiology, and Microbiology, Prague). Voj. Zdravot. Listy, 36: 108-11(June 1967). (In Czech).

Separation of radioiodine from tap water is discussed. The best method for ambulatory laboratories is separation by an extraction method and measurements of radioactivity of the iodine in the form of AgI using a GM counter tube, or by means of an organic solvent in a hollow crystal. In serial analyses separation by continuous flow chemisorption is recommended. (ATD)

6816 RADIATION ACCIDENTS IN PEACE. PART II. DETERMINATION OF THE DOSE ACCORDING TO DOSIMETRY AND LABORATORY EXAMINATIONS. Hajek, Vlastimil (Slovak National Uprising Military Hospital, Ruzomberok, Czech.). Voj. Zdravot. Listy, 36: 122-8(June 1967). (In Czech).

Accurate determination of the amount of radiation to which people become exposed accidentally is difficult to make; in serious accidents the usual personnel protection devices become overloaded. The part of the body that is subjected to radiation is important in the determination of the extent of the resulting injury. Various well known accidents that occurred recently are reviewed. Symptoms provoked by radiation are described, and their seriousness evaluated. Suitable methods of diagnosis are described. (ATD)

6817 ^{210}Po IN MARINE PLANKTON. Shannon, L. V. (Div. of Sea Fisheries, Sea Point, South Africa); Cherry, R. D. Nature (London), 216: 352-3(Oct. 28, 1967).

Very little work appears to have been done on ^{210}Po or ^{210}Pb in the marine environment. The primary purpose of the studies described was to establish the general level of ^{210}Po in marine plankton samples. Alpha counting measurements were made on a large number of samples obtained from the seas around the Cape of Good Hope during 1965 and 1966. The total alpha activity of a sealed sample, and the thorium series contribution to this, were measured and the uranium series activity obtained by subtraction, the variation of this activity with time being studied. Most of the zooplankton samples and all of the phytoplankton samples showed a decrease in uranium series activity on a time scale of the order of several months. This decrease was consistently interpreted as a result of ^{210}Pb-unsupported 138-day ^{210}Po, and the amount of un-

supported ^{210}Po present in the samples at the time of collection was calculated by extrapolation. The modal value obtained was ~3 pc/g dry plankton, or ~200 pc/g wet plankton. This is more than an order of magnitude greater than the total ^{210}Po reported in human soft tissues. The radiation dose from the level quoted is ~200 m rem/yr, compared with a total background dose to man from all sources of ~130 m rem/yr. Some data for fish are also quoted. The plankton samples also showed a time-independent alpha activity of mean value 2.3 pc/g dry plankton, due principally to uranium, radium and daughters (excluding unsupported ^{210}Po). The contribution of supported ^{210}Po to this mean is uncertain, but is probably not greater than 0.2 pc/g. It is concluded that the enrichment factor from sea water to plankton must be larger for ^{210}Po than for ^{210}Pb; for ^{210}Po it appears to be >4,000. The mean unsupported ^{210}Po activity in the zooplankton samples was 4.7 pc/g dry weight, and for the phytoplankton samples 2.8 pc/g. There was a tendency for off-shore samples to contain higher unsupported ^{210}Po activity. (UK)

6818 LABOR CONDITIONS AND STATE OF HEALTH OF PERSONS WORKING AT RESEARCH NUCLEAR REACTORS. Gus'kova, A. K.; Denisova, E. A.; Moiseitsev, P. I.; Korlyakova, E. A.; Sizikova, N. V. (Inst. of Industrial Health and Occupational Disease, Moscow). Gig. Sanit., 9: 39-43(Sept. 1967). (In Russian).

Hygienic features of labor conditions prevailing at research nuclear reactors of various types are described. The main unfavorable occupational factors are the external gamma and neutron radiations and the contamination of the environment with radioactive substances. The elaborated principles of planning, protecting, and equipment provide safe working conditions. The levels of various kinds of irradiations do not exceed the maximal permissible values. The state of health of persons working at reactors is quite satisfactory. No cases of chronic radiation sickness were registered. (auth)

6819 DEPENDENCE OF THE MAXIMUM PERMISSIBLE DOSE ON THE ENERGY OF X-RAY OR GAMMA-IRRADIATION. Bronshtein, I. E.; Krisyuk, E. M.; Liberman, A. N. (Leningrad Scientific-Research Inst. of Radiation Protection). Gig. Sanit., 9: 47-50(Sept. 1967). (In Russian).

Experiments are based on the previously determined correlations between the general biological effect on the body and that produced in certain critical organs with the average consumed dose. The authors' calculations make it possible to determine the maximum permissible doses of irradiation of the whole body, the crystalline lens, the skin and the male gonads by the gamma and x rays. (auth)

6820 CHOICE OF DETERGENT MIXTURES FOR SKIN DECONTAMINATION FROM RADIOACTIVE CONTAMINATIONS. Vorob'ev, A. M. Gig. Sanit., 7: 45-9(July 1967). (In Russian).

The experimental background for the preparation of detergent mixtures for use for removal of radioactive contaminants from skin is discussed. The best decontaminating effect was produced by a complicated mixture containing surface-active substances, certain complex components, and solid bases. The best ratio of these ingredients in the mixture of detergents was determined. The specific role of each component in the mixture and the effects of some components on the action of others and on the deactivating property of the whole mixture were determined. The best mixtures of detergents were worked out for skin deactivation from a large variety of radioactive isotopes. (auth)

6821 RELIABILITY OF PREDICTIONS OF THE CONTAMINATION OF MILK WITH FISSION PRODUCTS IN THE UNITED KINGDOM. Bartlett, B. O. (Agricultural Research Council, Wantage, Eng.). Nature (London), 216: 385-6(Oct. 28, 1967).

An equation is discussed which has been found to give a satisfactory relation between the annual average levels of contamination of milk with ^{90}Sr and ^{137}Cs and the deposition of fall-out during 1958 to 1964. It was found that calculated and observed levels agreed closely for each of the years for which data were used. The proportion of the total ^{90}Sr in milk attributable to uptake from the soil was 43% in 1965 and 63% in 1966, as compared with 20 to 25% in years of high deposition. The equation underestimated levels of ^{137}Cs in milk by 20% for 1965 and 1966. This is considered adequate for practical purposes, but results for a considerably longer period should be assembled before a soil factor for ^{137}Cs can be derived with confidence. An interesting finding is that contamination of milk with both nuclides is influenced to an appreciable extent by rate of fallout in the preceding year. It is pointed out that, in actual fact, the processes which control the transfer of ^{90}Sr to milk are much more complex than the equation implies, but present information provides no basis for eliminating these defects. (UK)

6822 EVACUATION AND TREATMENT OF THE SICK AND SLIGHTLY WOUNDED AS A RESULT OF THE USE OF NUCLEAR WEAPONS. Petrov, M. (Higher Military Medical Inst., Sofia). Voenno Med. Delo, 22: No. 2, 3-8(Apr. 1967).

The evacuation and treatment of cases of light injuries caused by the action of nuclear weapons under wartime conditions is considered. Estimates are given of the ratio of injured of this type to the total number of injured. It is stated that according to Kapilevich and Aleksiyev, this ratio should not exceed 35% because of the prevalence of severe injuries from nuclear weapons. Treatment of cases of light injuries from nuclear weapons (including those of radiation sickness caused by exposure to doses of 100 to 200 R) should be in hospitals for the lightly wounded equipped for appropriate surgical aid and especially reorganized for the purpose. (JPRS)

6823 RADIATION MEASUREMENTS REQUIRED FOR MANNED SPACE FLIGHT. pp 49-56 of Radiobiological Factors in Manned Space Flight. Langham, Wright H. (ed.). Washington, D. C., National Academy of Sciences–National Research Council, 1967.

Continuous monitoring of a space crew's radiation exposure is necessary both for the short-range effects on performance and for long-term records of accumulated doses for each astronaut. Dose estimation in space is difficult because of the nonuniformity resulting from the continuously changing of the space-radiation environment. It is recommended that a system be developed that records both dose rate and total absorbed dose in rads as a function of mission time. Absorbed dose should be measured both superficially and at critical depth in the body. The dose should be weighted for LET distribution if a significant fraction of the dose at the sites of interest is delivered at high LET. Both a mounted stationary dosimetric system and portable sensors attached to the body appear to be necessary. If heavy nuclei are excluded, the LET problem is of less importance for the remaining portule of galactic radiation. Except under special circumstances separate determination of LET would appear unnecessary and measurement of the dose in rads and application of a suitable QF factor to the skin may suffice. (M.M.B.)

6824 SELECTION OF RESPONSE CRITERIA AND THEIR APPLICATION TO SPACE-RADIATION RISKS. pp 243-66 of Radiobiological Factors in Manned Space Flight. Langham, Wright H. (ed.). Washington, D. C., National Academy of Sciences–National Research Council, 1967.

The Space Radiation Study Panel of the NRC concluded that internationally accepted standards for occupational radiation protection cannot be applied unconditionally to manned space flight. Radiation is only one among many potential risks to the success of any flight mission: astronauts differ in number and functions from any other groups occupationally exposed to radiation; space-radiation risks are not precisely predictable and a risk-versus-gain philosophy must be applied to each individual mission. Criteria and guidelines for evaluation of risks are presented. (M.M.B.)

6825 CHANGES OF CONCENTRATION OF ^{90}Sr AND ^{137}Cs IN RAW MILK COLLECTED AT DAIRY FACTORIES IN TOHOKU DISTRICT IN JAPAN DURING MARCH, 1963–JANUARY, 1965. Nakanishi, Takeo; Sugawara, Hiroshi (Tohoku Univ., Sendai). Rakuno Kagaku No Kenkyu, 14: A255-68(Dec. 1965). (In Japanese).

Dairy factories in Tohoku District (Northeastern District) of Japan are sampled every other month and the samples analyzed for ^{90}Sr and ^{137}Cs. The concentrations of ^{90}Sr and ^{137}Cs in milk showed peaks (44 $\mu\mu c$ and 39 $\mu\mu c$ ^{90}Sr/l milk, 302 $\mu\mu c$ and 222 $\mu\mu c$ ^{137}Cs/l milk) in July, 1963 and 1964, respectively. It is assumed that the results related to higher amounts of radioactive fallout including ^{90}Sr and ^{137}Cs in May and July in 1963 and 1964. In 1964, average concentrations of ^{90}Sr and ^{137}Cs in milk tended to be higher in the north part (40 $\mu\mu c$ ^{90}Sr/l milk and 180 $\mu\mu c$ ^{137}Cs/l milk), than in the south part of Tohoku District (27, 22, 18 $\mu\mu c$ ^{90}Sr/l milk and 132, 110, 109 $\mu\mu c$ ^{137}Cs/l milk. Maximum values of ^{90}Sr in milk had a tendency to increase in 1959 and 1964, but that of ^{137}Cs was not so variable in 1959 to 1964. (auth)

6826 RADON-GENERATING ACTIVITY IN DIFFERENT GALICIAN SOILS IN RELATION TO OTHER GREAT WORLD GROUPS AND THE TOTAL LEAD CONTENT. Dios Vidal, Ramon (Instituto Politecnico Espanol, Pontevedra, Spain). An. Edafol. Agrobiol. (Madrid), 23: 53-63(1964). (In Spanish).

Data are presented on the ^{222}Rn-generating potential of different Galician prairie soils formed from granite and gneiss parent material, the mean annual rainfall being about 160 cm. Comparisons with a variety of major soil types throughout the world were made. The number of Ci of ^{222}Rn escaping from 2500 g of soil material, at equilibrium with its parent Ra, in some Galician soils is much

greater than in the other soil types that were compared, reaching a maximum of 25×10^{-10} Ci/l of soil atmosphere activity or 96×10^{-14} Ci/g of dry soil. The middle and lower parts of the soil profile showed, in general, higher Rn-generating potentials but a low correlation was found between this and the clay fraction of the soil. However, the maximum activity corresponded with soils of higher (11%) clay content. Values of Rn released by the soil in boiling water- and ammonium hydroxide-treated suspensions are also given. The Rn-generating power of the ammonium hydroxide solution was greater than in the water suspensions and in untreated soil material. The accumulation of Pb in soils and its absorption by native plants, such as Ulex nanus, Pteris aquilina, and Carinephorus canescens, showed low correlation with Rn generation, even though the soils with highest Rn levels provided for most of the Pb concentration in soils and plants. (BBB)

6827 ^{90}Sr AND ^{137}Cs CONCENTRATION IN IMPORTED FOODS. I. Kametani, Katsuaki; Ikebuchi, Hideharu Eisei Shikesho Hokoku, No. 83, 74-6(Oct. 1965). (In Japanese).

The ^{90}Sr and ^{137}Cs content of buttermilk, wheat, and soybeans imported from the United States was determined. The highest content of ^{90}Sr in the buttermilk and in the wheat were 61.8 $\mu\mu$Ci/100 g and 82.7 $\mu\mu$Ci/100 g, and the mean values were 29.9 $\mu\mu$Ci/100 g and 31.5 $\mu\mu$Ci/100 g, respectively. When the mean values of ^{90}Sr and ^{137}Cs in the buttermilk and wheat were compared, there was no difference between the buttermilk and wheat for the content of ^{90}Sr, but the content of ^{137}Cs was much lower in the wheat than in the buttermilk. The contents of ^{90}Sr and ^{137}Cs were fairly low in the soy beans. These foods were produced in Minnesota, Iowa, North Dakota, Nebraska, and Wisconsin. The values agreed with those reported from the United States. (auth)

6828 RADIOACTIVE CONTAMINATION OF DRINKING WATER. Spaander, P. Vierde Macht, 15: 54-8(Apr. 1966). (In Dutch).

The contamination of drinking water occurring as a result of atomic bomb explosions is considered. The principles used in the calculation of the maximum permissible concentrations in water are outlined, and the permissible dose for internal radiation is given. The radiation dose of the population considered in its entirety is calculated. The maximum permissible concentration after an atomic bomb explosion is tabulated for ^{131}I, ^{137}Cs, ^{89}Sr, and ^{90}Sr. (J.S.R.)

6829 RADIATION IN SPACE. Neuman, William F. (Univ. of Rochester, N. Y.). pp 205-42 of Human Ecology in Space Flight. Proc. First Intern. Interdisciplinary Conf., Princeton, N. Y. Oct. 13-16, 1963. Calloway, D. H. (ed.). New York, New York Academy of Sciences, 1966.

The extent to which humans will be exposed to cosmic radiation in manned space flight is discussed. The cosmic radiation flux reaching earth is not uniform because of the interaction of the earth's magnetic field. The poles receive the full intensity of the flux, but at the equator bending of all the lower energies occurs, and those particles above 15 BeV actually break through the magnetic barrier at the equator. Thus, there is a strong latitudinal variation in the distribution of energy from cosmic radiation reaching earth. It is estimated from measurements in balloons and space probes that the intensity of cosmic radiation is ~12 mrad per day at the surface of the atmosphere; it may be as high as 25 mrad per day in deeper space. On the basis of the rad equivalent as an estimate of the hazard, the cosmic flux is not considered a serious hazard affecting the space traveler. However, solar flares that would last as long as two or three days would perhaps deliver a total dose of ~1000 rad. It might be necessary to use a statistical approach to launch missions at times in which low sunspot activity is expected on the basis of the known 11-yr cycle plus some superimposed smaller cyclic variation. As for the geomagnetically trapped radiation, the Van Allen belts do not seem to pose any serious hazard but may cause some limitations. The belts could be traversed in a short enough period to result in only small doses. The inner belt is estimated to give upwards from 20 R/hr behind a 1 g/cm^2 shield. Doses expected to be received by crews in nuclear-powered space vehicles are also evaluated. It was estimated that in a Martian orbital and landing mission with a 21,000-Mw reactor, if 25,000 lb of shielding is used, about two rad would be delivered to the crew. If the shielding is decreased to 10,000 lb, the dose increases to 117 rad/mission. (BBB)

6830 SOURCE OF ^{210}Po IN PLANTS. Francis, Chester Wayne. Madison, Wis., University of Wisconsin, 1967. 83p. Thesis.

This investigation was initiated to determine the ^{210}Po content of plant materials, soils and rainwater to establish the source and mode of entry of ^{210}Po into plants. Two basic methods were used to isolate ^{210}Po from soil and plant tissue, namely, the digestion of the plant tissue or soil sample with concentrated HCl and the oxidation of plant tissue samples with a mixture of concentrated H_2SO_4, 60% $HClO_4$, and concentrated HNO_3 or a decomposition of soil samples with a mixture of concentrated H_2SO_4, 60% $HClO_4$ and 48% HF. Because ^{210}Po is the only α emitter that spontaneously deposits electrochemically on Ag in dilute HCl, ^{210}Po was isolated from the digestate by plating on Ag disks; the α-activity was determined by a semiconductor solid state detector. The recovery, by the concentrated HCl digestion method, of ^{210}Po added to plant tissue samples averaged 78% with a standard deviation of ±17%. Average recovery by the wet ashing procedure ($H_2SO_4-HClO_4-HNO_3$) was 102 ± 10%. Thus, the concentrated HCl provided insufficient digestion for isolation of ^{210}Po from plant tissue, even though it has been used extensively in the past. Similarly concentrated HCl digestion of soil samples gave lower recoveries of ^{210}Po than the decomposition method ($H_2SO_4-HClO_4-HF$). By the $H_2SO_4-HClO_4-HF$ decomposition technique, recovery of ^{210}Po added to a variety of soil samples was 100 ± 3%; HCl digestion gave 60 to 91% of the ^{210}Po contents obtained by $H_2SO_4-HClO_4-HF$ decomposition. Determination of ^{210}Po contents at intervals of three months over a one year period showed that radioactive ingrowth of ^{210}Po occurred in stored tabacco leaves. The increase in ^{210}Po content during storage showed ^{210}Po was derived from and therefore in radioactive equilibrium with ^{210}Pb. Extrapolation of rate of ingrowth curves obtained by a modified Bateman equation established that ^{210}Po entered the plant before curing and during the growing season. Because the ^{210}Po content of greenhouse cured tobacco leaves sealed in glass jars after harvest and air drying were similar, it was concluded that ^{210}Pb did not enter the tobacco leaves during the curing process. A number of experiments were designed to evaluate the mechanism of ^{210}Po entry into plants as follows; measurement of ^{210}Po uptake by plants in nutrient culture, comparison of the ^{210}Po contents of leaf tissue grown in greenhouse soil culture with leaf tissue grown under field conditions and exposed to natural radioactive fallout, and measurement of ^{210}Po contents of rainwater. Five kinds of evidence are presented showing that ^{210}Po or ^{210}Pb does not enter plants by direct uptake from the soil; ^{210}Po from nutrient solutions is not translocated readily to the aerial portions of the plant, no detectable quantities of ^{210}Po were found in the center of dead cabbage heads left in the field over winter while the outer leaves contained as much as 5.4 pCi/g, common extracting solutions used to evaluate available forms of many mineral elements in soils failed to extract detectable amounts of ^{210}Po, after sufficient time for ingrowth, no detectable quantities of ^{210}Po were found in greenhouse cultured corn, tobacco, ryegrass, and peas while appreciable quantities (0.56 to 1.65 pCi/g) were found in the leaf tissue of field grown crops, adequate amounts of ^{210}Pb were found in rainfall for all ^{210}Po in field grown crops. The rate of ingrowth of ^{210}Po in rainwater collected during the summer of 1966 was determined. Aliquots of rainwater were subdivided into two fractions; dust particles retained on a 0.22μ Millipore filter, and the filtrate containing particulate matter <0.22μ in diameter. Ingrowth of ^{210}Po in the filtrate fraction was observed but the ^{210}Po and ^{210}Pb in the dust fraction >0.22μ were in steady state equilibrium. From calculation of the rate of ^{210}Po ingrowth in the filtrate fraction the mean residence time of ^{210}Pb in the troposphere was calculated to be approximately eight days. The distribution of ^{210}Po in virgin soil profiles indicated that ^{210}Po or its immediate precursors are not readily leached. In addition, oxidation and iron oxide removal treatments on intact soils and soil separates, clay, silt and sand, showed that ^{210}Po is very immobile in soil systems and is likely irreversibly sorbed on clay and organic colloids. (auth) (Disser. Abstr.)

6831 DEPTH-DOSE DISTRIBUTIONS FOR FALLOUT AND SIMULATED FALLOUT FIELDS. French, R. L. (Radiation Research Associates, Inc., Fort Worth, Tex.); Garrett, C. W. 27p. (CONF-660920-18). DTIE.

From 1st International Congress of the International Radiation Protection Association, Rome.

Gamma-ray depth-dose patterns in a phantom exposed to fallout were calculated by the Monte Carlo method. The phantom consisted of a tissue equivalent vertical right cylinder 60 cm in height and 30 cm in diameter. The center of the phantom was 111.8 cm above a smooth ground surface uniformly contaminated with ^{235}U fission products. The energy and angular distribution of the gamma rays incident upon the phantom were taken from a previous Monte Carlo study. The depth-dose patterns were found to be relatively insensitive to fallout age over the period investigated (1 hour to 9 days). The dose rate at the center of the phantom is approximately 65 percent of the free-field dose rate, while that at the lateral surface is approximately 80 percent. Except near the extremities, the dose rate along the vertical axis of the phantom varies at approximately the same rate with height above ground as does the free-field dose rate. Approximately one-half of the dose rate at the center of the phantom is from photons that have suffered previous collisions in

the phantom. The depth-dose patterns were also calculated for two arrangements of artificial sources that although not duplicating the fallout energy spectra, were intended to simulate fallout biological effects. The patterns produced by revolving the phantom on its vertical axis while exposed to a point ^{60}Co source at a horizontal distance of 61 meters are similar to those from the fallout, except for internal positions near the bottom of the phantom. A special arrangement of ^{60}Co, ^{137}Cs, and ^{144}Ce sources produced substantially the same depth-dose patterns throughout the phantom as did the fallout. (auth)

Medicine

Refer also to abstracts 6566, 6661, 6693, 6722, 6749, 6822, 6871, 6883, 6887, 6888, 6890, 6894, 6896, 6908, 6909, 6911–6913, 6924, and 6929.

6832 (CONF-661010) COMPARTMENTS, POOLS, AND SPACES IN MEDICAL PHYSIOLOGY. AEC Symposium Series 11. Proceedings of a Symposium, October 24–27, 1966. Bergner, Per-Erik E.; Lushbaugh, C. C.; Anderson, Elizabeth B. (eds.) (Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.). Aug. 1967. 521p. Dep. CFSTI.

Papers were presented on: body composition in applied human biology; definition of pool and space; concepts of mass, volume, and concentration; significance of potassium and sodium masses in cardiac disease; lean body mass and whole-body potassium; determination of whole-body sodium, calcium, and chlorine by whole-body neutron activation; multicompartment analysis of steady-state and nonsteady-state systems; computer methods in metabolic studies; two-compartment model with a random connection; total body water in man; effect of surgery on volume distribution of extracellular fluid determined by sulfate and bromide methods; extracellular fluid in individual tissues in relation to extracellular fluid in the body as a whole; cardiovascular system; plasma and erythrocyte volumes in obesity, polycythemia, and related conditions; albumin pool; body masses and metabolic rates of gamma globulin; iodine pool; iron pools; organ vascular and extravascular compartments in vivo; distribution of substances in the liver; and calcium pools and the power function. (W.E.D.)

6833 (CONF-671027–1) EXPERIENCE WITH AN ON-LINE ACQUISITION AND CONTROL SYSTEM. Brill, A. B. ([Vanderbilt Univ., Nashville, Tenn.]). [nd]. 16p. Dep. CFSTI.

From Nuclear Medicine Society, Lexington, Ky.

A computerized system designed for whole-body counting or rectilinear scanning for use in medicine is described. Count and position information obtained from each scanner is processed and routed by a data routing interface to a memory system. The data addressed into memory are continuously displayed on the face of the contour-volumetric display and may be varied by manipulation of contrast and intensity controls and background cut-off controls during collection of the scan. Data from memory are read out onto digital magnetic tape using a special patch panel with the same programmable digital logic interface that is used for data routing. Either black and white or color pictures of scans may be obtained. Using a dual detector system and collimator for whole-body or rectilinear scanning, simultaneous detection of two radioisotopes is possible. The performance of the system for the production of high-quality scans by means of computer-smoothed data is discussed. (C.H.)

6834 (UCLA–12–656) BRONCHIAL PATENCY AND AERATED SPACE ASSESSMENT BY SCINTISCANNING. Taplin, George V.; Poe, Norman D.; Dore, Earl K.; Greenberg, Al (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). Sept. 5, 1967. Contract AT(04-1)-Gen-12. 46p. (CONF-670940–2). Dep. CFSTI.

From Symposium on the Clinical Applications of Nuclear Medicine, Boston, Mass.

The basic concepts, test agents, techniques, and equipment for performing inhalation lung scintiscans are described. The pathophysiological significance of abnormal scan findings are demonstrated in controlled animal experiments. The results of combined radioaerosol inhalation-perfusion scanning in more than 500 patients are condensed by presenting representative cases that illustrate the reproducibility and clinical value of both types of scintiscanning procedures in a wide variety of cardiopulmonary disorders. The perfusion scan has the greater diagnostic value especially in the early detection of both minor and major pulmonary embolism. Both scintiscanning techniques are practical methods for evaluating regional pulmonary function because of their unique capacity to disclose localized areas of pulmonary ischemia or abnormally aerated lung. Scans, angiograms and bronchograms are not competitive procedures. They provide different kinds of information and when coordinated each enhances the value of the other. The same can be said for scans and plain chest films. Radioaerosol inhalation scanning has fewer applications than perfusion scanning and its diagnostic value is limited to the detection of partial and/or complete bronchial obstruction. However inhalation scanning gives a better estimate of pulmonary function in obstructive bronchopulmonary disease as in emphysema than does perfusion scanning. Both types of scanning procedures are valuable adjuncts to radiography and pulmonary function tests whenever assessment of regional arterial perfusion and airway patency is needed to guide the course of medical or surgical treatment. The potential diagnostic value of combined inhalation-perfusion scanning is discussed and specific clinical conditions are defined which need further investigation. (auth)

6835 (AEC-tr–6467/2 pp 195-222) INSTRUCTIONS AND METHODICAL SPECIFICATIONS FOR PREVENTIVE MEASURES, DIAGNOSIS, AND TREATMENT OF CHRONIC RADIATION SICKNESS. Translated from Sbornik Vazhneishikh Ofitsial'nykh Materialov po Voprosam Gigieny Truda i Proizvodstvennoi Sanitarii, Gosudarstvennoe Izdatel'stvo Meditsinskoi Literatury, Moscow, 1962.

Procedures for the diagnosis and treatment of chronic radiation sickness in man are described. The pathology of radiation sickness, radiation injuries of the skin, and radioinduced cataracts are described, and the use of diet, drugs, hormones, and blood transfusions in the treatment of radiation sickness is discussed. Standards for the maximum permissible dose of extraneous γ and x radiation are presented. Legislation of the U.S.S.R. governing occupational exposure to radiation is discussed. (C.H.)

6836 CLINICAL OBSERVATIONS ON THE ATOMIC BOMB SURVIVORS. V. Yokota, Soichiro (Nagasaki Atomic Bomb Hospital). Nagasaki Igakkai Zasshi, 40: 683-8 (Aug. 1965). (In Japanese).

Clinical observations on atomic bomb survivors made from October, 1963 to September, 1964 are reported. Among 5082 subjects seen as outpatients, 551 cases were accepted for hospitalization. The diseases observed in atomic bomb survivors examined in the hospital included circulatory disturbances (97 cases), malignant tumor, gall bladder disorders, and hormonal disturbances. There were 16 cases of hematologic disease. The mortality of inpatients during this period was 48 cases. Hematologic disturbances were the most serious effects attributable to the atomic bomb radiation. However, there were relatively few cases of this type during this period. Hematologic disease cases were distributed as follows: 3 cases of acute myeloid leukemia, 2 cases of chronic myeloid leukemia, 4 cases of malignant anemia, and several cases of polycythemia vera, agranulosis, and other conditions. One acute leukemia patient had been exposed at the distance of 1 Km from the explosion and showed acute radiation symptoms at that time and hemorrhagic phenomena later. Among 37 cases of leukemia in the atomic bomb survivors during the past several years, 60% were of acute myeloid leukemia and the others chronic myeloid leukemia, monocytic leukemia, and chronic and acute lymphatic leukemia. The incidence of malignant tumors in atomic bomb survivors has increased in recent years. There were 77 cases of malignant tumors during 1963 and 1964 in atomic bomb survivors, accounting for 56.2% of the whole mortality experience in this group. Among these malignant tumors, stomach cancer sho[w] the highest proportion, the other tumors including those of th[e] all bladder, intestine, breast, thyroid, and liver. (BBB)

6837 STUDIES ON ATOMIC BOMB RADIATION EFFECTS ON ANTIBODY FORMATION. (APPLICATION OF THE FRANCIS DOCTRINE OF ORIGINAL ANTIGENIC SIN). Kato, Hiroo (Atomic Bomb Casualty Commission, Hiroshima); Oonisi, Sigeyuki; Finch, S. C.; Kanemitsu, Masatsugu; Morita, Katsuhiko. Nagasaki Igakkai Zasshi, 40: 666-7 (Aug. 1965). (In Japanese).

Immunological studies on possible atomic bomb radiation effects on antibody formation are reported. A group of 323 infants from atomic bomb-exposed mothers (Hiroshima 244 and Nagasaki 79) were vaccinated with A_2 type monovalent influenza vaccine. The blood was collected before and four weeks after vaccination, and specific complement-fixing antibody was measured. Another group of 39 atomic bomb survivors, 0 to 2 yr of age at the time of exposure, were used as controls. According to the Francis doctrine of original antigenic sin, considered in terms of infection with various types of influenzae virus during a lifetime, antibody formation would be most sensitive to and enhanced by infection with the first virus strain contacted after birth. The results showed that at the time of first influenza infection in infant atomic bomb survivors, antibody formation was inhibited and its amnestic response remained weak. The results on the distribution of antibody to other influenza strains showed that the FM2 antibody titer was higher than the titer of antibodies to the other strains tested (A, A1, PR8, Weiss). Correlation between antibody titer and distance

from the hypocenter of the detonation revealed that the FM1 antibody titer of Nagasaki survivors at proximal distance (<2000 m) was lower than in the controls. Other types of antibody did not show any such correlation. In A2 type antibody of Hiroshima subjects, the antibody titer for proximal distance survivors was higher than in controls. The increase in FM1 antibody was relatively low in Hiroshima and Nagasaki atomic bomb survivors for 1500 m or closer distance from the hypocenter of the explosion. (BBB)

6838 LIVER CIRRHOSIS AND PRIMARY HEPATIC CARCINOMA. Sato, Tachuo (Atomic Bomb Casualty Commission, Hiroshima). Nagasaki Igakkai Zasshi, 40: 649-51(Aug. 1965). (In Japanese).

Pathological analyses of cirrhosis of liver and primary hepatic carcinoma among atomic bomb survivors in Nagasaki and Hiroshima are reported. Up to August, 1963, the incidence of cirrhosis in various autopsy series was 69 cases (5.6%) in Hiroshima and 10 cases (2.8%) in Nagasaki. In comparison with the data averaged for the whole of Japan (2 to 5%) or Europe and the United States (4.6%), the incidence rate in Hiroshima was slightly higher. According to Gall's classification, most cirrhosis cases belonged to postnecrosis and posthepatitis types. Nutritional cirrhosis was found in only two cases in Hiroshima and one case in Nagasaki. The incidence rate of the complication of liver cirrhosis with primary hepatic carcinoma was 11.6% in Hiroshima and 60% in Nagasaki. Almost all hepatic carcinomas belonged to the parenchymal cell type. The incidence of liver carcinoma in Hiroshima was lower than the data for the whole of Japan (22 to 24%) or Southeast Asia (20 to 25%). However, it was higher than that in Europe (3 to 7%) and the United States (10%). The incidence of liver cancer in Nagasaki was unusually high. Among these cases of cirrhosis, 77% were atomic bomb survivors, but there was no correlation between the incidence rate and distance from the hypocenter of the atomic bomb explosion. It was considered that the effect of ionizing radiation on liver pathology was negligible and that socioeconomic factors were more important, such as leading to infectious hepatitis which resulted in development of cirrhosis. (BBB)

6839 SERUM PROTEINS OF ATOMIC BOMB SURVIVORS (CONTAINING RESIDUAL RADIOACTIVITY). Makidono, Jun (Makidono Radiology Clinic, Hiroshima); Takanasi, Shingo; Yoshimoto, Tsutomu; Yoshimoto, Kichiro; Machudani, Mamoru; Miura, Motoi. Nagasaki Igakkai Zasshi, 40: 645-8(Aug. 1965). (In Japanese).

Electrophoretic studies on the serum proteins of atomic bomb survivors are reported. A group of 100 survivors was examined in 1963 and, among these, 22 cases were reexamined in 1964. A normal (N) pattern was distinguished from a β pattern (β-globulins predominating over other globulins) and a γ pattern (the γ-globulin peak highest and greater than in normal serum). The electrophoretic patterns of serum proteins changed in this one-year interval. The N pattern was present in 57% in 1963 and 59.1% in 1964, the β pattern changed from 39% to 27.7% and γ pattern from 4% to 13.6%. Among 48 early entrants into Hiroshima after the bombing, a 85.7% decrease in β pattern was observed after one year. However, no change in N and γ patterns was observed. During the radiotherapy of cancer patients a temporary change of N pattern to β pattern was observed and a later return to the original N pattern. Among 33 cancer patients abnormal electrophoretic patterns of serum proteins were observed; 52% of N, 48% of β, and 0% of γ patterns. In a case of stomach cancer, irradiation was conducted before and after surgery. Immediately after irradiation the N pattern was changed to β and after the complete recovery it reverted to the N pattern. These results showed the β pattern reflected a labile serum protein, and the N and γ patterns relatively stable ones. However, γ-globulin tended to be increased after irradiation. (BBB)

6840 BONE MARROW GRAFT. Mathe, G.; Amiel, J.-L. (Institut Gustave Roussy, Villejuif, France). Bibl. Haematol., 23: 122-33(1965). (In French).

The use of whole-body irradiation with bone marrow grafting in the treatment of leukemia in man and various animal species is reviewed, along with data on the survival of accidentally irradiated persons treated by bone marrow infusions. Three different applications of allogenic bone marrow grafts are indicated by experimental studies: first, replacement treatment of myeloid insufficiency; second, the induction of specific immune tolerance for allogenic tissue graft and organ transplantation; and third, therapy of disseminated cancer, especially acute leukemia. The first method involves whole-body irradiation. A subject receiving 800 R and an isogenic bone marrow transfusion was observed to have a quick recovery and a few weeks later to show chromosomal anomalies along with a high myeloid mitotic rate. The practical difficulties of allogenic bone marrow grafting fall into 2 categories: acceptance of the graft itself and appearance of the secondary syndrome. Another important cause of failure of allogenic hematopoietic cell grafts may be cross-immunization owing to previous blood transfusions. (BBB)

6841 AN INTERESTING CASE OF LUNG CANCER. Hujimoto, Yukio; Ishida, Sadamu; Yorita, Kiyo; Yorita, Etsuko; Tateishi, Riuhei (Hiroshima Atomic Bomb Hospital, Japan). Nagasaki Igakkai Zasshi, 40: 629-31(Aug. 1965). (In Japanese).

There have been 45 cases of lung cancer admitted to the Hiroshima Atomic Bomb Hospital since 1956. The case reported here showed chronic development of symptoms during a 2-yr period, then the symptoms rapidly became more severe. The patient was a 54-yr-old male, exposed to the atomic bomb explosion at a 1.5 Km distance. He had incurred injuries of the face and legs. Three years later there was a swelling of a lymph node in the right chest. From Jan., 1961, cough and sputum were present but there were no positive findings by x-ray examination. In June, 1962, the patient visited the Hiroshima Atom Bomb Hospital. There was swelling of the right lung and a massive dark shadow in the lower lobe upon x-ray examination. From October, 1962, pain in the right chest and enlargement of the dark shadow were noted. Bloody sputum and severe dyspnea were noted in February 1963, and the symptoms worsened rapidly. Many vacuoles and small round infiltrations were seen in the entire lung. The patient was treated by intravenous injection of Endoxan (100 mg) and the dyspnea gradually disappeared. The antibiotics were administered for 18 days and the symptoms were much improved; the dark shadow in the lower lobe and the vacuoles and small round infiltrations almost disappeared. However, the symptoms recurred after cessation of drug administration. They became worse gradually and the patient died in January, 1964. Autopsy examination showed there was an epithelial tumor in the right lower lobe, 3.5 cm in dia. A lymph node in the right lung was swollen and a necrotic area was observed in the center. (BBB)

6842 DIELECTRIC ABSORPTION OF MICROWAVES IN HUMAN TISSUES. Mallard, J. R.; Lawn, D. G. (St. Thomas's Hospital, London). Nature (London), 213: 28-30(Jan. 7, 1967).

Calculations show that differences in absorption of microwaves by the human body may be a means of localizing tumors and some body structures. (auth) (UK)

6843 THE SEQUESTRATION OF RED CELLS LABELLED WITH BMHP-^{197}Hg AS A TEST OF SPLENIC FUNCTION. Spinelli-Ressi, F.; Cattaneo, N.; Banfi, F. (Ospedale Maggiore, Milan). J. Nucl. Biol. Med., 11: 9-16(Jan.-Mar. 1967).

The clearance from the blood of red cells labeled with Hg-labeled 1-bromo-mercuri-2-hydroxypropene (BMHP-^{197}Hg) and the spleen and liver uptake were evaluated in normal subjects, in patients with congenital and acquired hemolytic anemia, in patients affected by acute and chronic leukemia, reticulum cell sarcoma, Hodgkin's disease and myelofibrosis and in splenectomized patients. In patients with congenital and acquired hemolytic anemia the blood clearance rate was always rapid and the splenic uptake higher than normal. In patients with chronic leukemia the clearance rate was often slower than normal and the splenic uptake lower than normal. In splenectomized patients the clearance rate was remarkably slower than normal. In the presence of a hemolytic state the clearance rate was always rapid and the splenic uptake high. These findings and the results of the tests carried out with donor red cells suggest that the rate of sequestration is not independent of the condition of the patient's erythrocytes prior to labeling. According to our studies, the test with red cells labeled with BMHP-^{197}Hg is a valuable tool to reveal a hemolytic state, to predict the result of splenectomy in patients affected by hemolytic anemia and to evaluate the degree of the changes of the spleen in a systemic disease; on the contrary, the test, by itself, is not able to state, in a case of high splenic sequestration, if the abnormality is due to the spleen or to the red cells. (auth)

6844 RADIOSENSITIZATION OF BACTERIAL AND MAMMALIAN CELLS BY SUBSTITUTED GLYOXALS. Ashwood-Smith, M. J.; Robinson, D. M.; Barnes, J. H.; Bridges, Bryn A. (Medical Research Council, Harwell, Eng.). Nature (London), 216: 137-9(Oct. 14, 1967).

Studies are described showing that methylglyoxal preferentially sensitizes anoxic bacterial and mammalian cells to the lethal effects of ionizing radiation. The radio-protective effect of anoxia on mammalian cells is effectively abolished in the presence of methylglyoxal, whereas sensitization of oxygenated mammalian cells is slight. (auth) (UK)

6845 INHIBITION OF RADIOSTRONTIUM ABSORPTION IN MAN. Spencer, Herta; Lewin, Isaac; Samachson, Joseph (Veterans Administration Hospital, Hines, Ill.). Int. J. Appl. Radiat. Isotop., 18: 779-82(Nov. 1967).

The ingestion of aluminum phosphate gel (100 to 300 ml) with

breakfast caused an average 87 percent decrease of the intestinal absorption of radiostrontium in man as judged by two different criteria: the marked decrease in the ^{85}Sr plasma levels and the increase in the fecal ^{85}Sr excretions after administration of an oral tracer dose. (auth)

6846 COMBINED RADIATION AND CHEMOTHERAPY. Raventos, Antolin (Univ. of Pennsylvania, Philadelphia). pp 58-64 of Current Perspectives in Cancer Therapy. Blakemore, William S.; Ravdin, I. S. (eds.). New York, Harper and Row, Publishers, 1966.

Recent data on the effectiveness of combined chemotherapy and radiotherapy for the treatment of cancer are reviewed. It is concluded that there is no evidence that the combination produces better results than radiation alone. (C.H.)

6847 FACTORS MODIFYING RADIATION RESPONSE. pp 27-48 of Radiobiological Factors in Manned Space Flight. Langham, Wright H. (ed.). Washington, D. C., National Academy of Sciences–National Research Council, 1967.

Biological responses (early and delayed) to radiation are dependent on radiation quality and type, dose distribution, and dose rate or fractionation. All of these are variables under space-environmental condition and their effect on man is mostly unknown or inferred from animal experiments. The application of RBE and QF-LET relations to evaluation of biological responses to different types of radiations is discussed. They apply when protons, alpha particles, electrons, and secondary-neutrons are being considered, but not to heavy galactic nuclei. Problems in estimating dose distribution and the distribution effectiveness factor (DEF) are discussed. All responses (prodromal reaction, early lethality, erythema, bone-marrow depression, and mutation rate) are dependent upon dose-rate. Other modifying factors may be age, sex, genetics, physiological condition, cabin environment, oxygen, temperature, drugs, and weightlessness. The development of a method for realistically determining the radiation status or well-being of an individual is critical for evaluation of the risks involved in long-duration missions. (52 references.) (M.M.B.)

6848 GEOMETRICAL AND PHYSICAL PARAMETERS IN WHOLE-BODY γ-RAY SPECTROMETRY MEASUREMENTS. Marinelli, L. D. (Argonne National Lab., Ill.). Excerpta Med. Int. Congr. Ser., No. 105, 1291-1301([1966]).

Whole-body counting systems are reviewed with emphasis on spatial relations between the subject and scintillation detector. It is pointed out that the sensitivity of the counting system will vary with the effective solid angle subtended by the scintillators at the radioactive sources and the self attenuation arising from the passage of photons through the body. The calibration of counting systems employing narrow and wide angle geometry and single or multiple detectors with or without collimators, is discussed. The influence of patient posture on counting results is considered. Effects of weight of people or phantoms on calibration factors and the limitations in the use of phantoms in clinical studies are discussed. The arc system using a GM counter, the Argonne chair, collimated scan systems, the 4π liquid scintillator system, systems using multicrystal arrays, and uncollimated multicrystal and multiposition crystal arrays are considered in relation to sensitivity to low levels of γ radioactivity in vivo. (44 references.) (C.H.)

6849 PROPHYLACTIC AND THERAPEUTIC ACTION OF NUCLEIC ACIDS DURING ACUTE RADIATION INJURY. Libinzon, R. E.; Rogacheva, S. A.; Rusinova, G. G. Radiobiologiya, 7: 455-8(1967). (In Russian).

The radioprotective effectiveness of DNA and RNA preparations was investigated in experiments on Wistar white rats weighing 180 to 190 g. DNA (spleen and liver) preparations were administered intraperitoneally (5 mg dose) to groups of experimental animals 15 min and three and six hr before irradiation and 10 to 30 min and three and 12 hr after irradiation. A commercial yeast RNA preparation in the form of a solution (12.5 mg/ml concentration) was administered intraperitoneally in 1 to 100 mg doses. Doses of RNA up to 2.5 mg were administered 10 min after irradiation and larger doses were administered fractionally at two hr intervals. To determine the effectiveness of DNA in relation to its molecular weight, DNA preparations (molecular weight 2 to 12×10^6) were administered 10 to 30 min after irradiation. All experimental animals were γ-irradiated (^{60}Co unit, 15 R/min) with a single 900 R dose, and were given biomycin per os daily (10 mg dose). Survival of animals was based on a 30 day period. Data show that for prophylactic purposes, DNA (molecular weight 2 to 4×10^6) administered three hr before irradiation produces the best results. For therapeutic purposes, DNA can be administered a few minutes and up to 12 hr after irradiation. Optimal therapeutic doses for RNA are 70 to 90 mg (85% survival rate for 70 mg and 84.2% survival rate for 90 mg). The therapeutic effect of DNA depended on its molecular weight. Possibly, the dependence of DNA therapeutic effect on molecular weight can be explained by the importance of the adsorption process in transporting DNA from the site of introduction to the cells. Other data show that DNA molecular weight plays a significant role in the adsorption process. (ATD)

6850 THE EFFECT OF VITAMIN B6 ON RADIATION INJURY. Orisaka, Hojun (Kyoto Prefectural Univ. of Medicine). Nippon Igaku Hoshasen Gakkai Zasshi, 26: 1439-47(Feb. 1967). (In Japanese).

The effect of vitamin B_6 against x-radiation injury was studied. The animals used were dd-strain male mice of average body weight of 15 g and male rabbits of about 2 kg body weight. Pyridoxine (PIN) was injected subcutaneously in mice and intravenously in rabbits. Thirty day-survival rates of mice administered 1 and 2 mg PIN or 0.2 ml saline solution for 10 days after irradiation (400 R) were 40, 35, and 5% respectively, and in the control mice (irradiation only) all the animals died within 20 days. There was no remarkable difference in survival rate between mice administered 2 mg PIN 10 min before and those administered it after irradiation (400 R). In the observation of leucopenia caused by irradiation (400 R) in mice, administration of PIN 2 mg for 10 days after irradiation had no effect on the severity of leukopenia, but accelerated the recovery. The same result was obtained in rabbits. Serum-total protein and albumin-globulin (A/G) ratio were measured in rabbits after irradiation (550 R). The animals given 50 mg PIN for 10 days after irradiation showed the most remarkable recovery. Decrease of glutamic oxalate transaminase (GOT) value in the liver was significantly less in the mice given PIN 2 mg for 10 days after irradiation (450 R) than in the control during the 15th to 30th day after irradiation. By means of bioassay, the total (pyridoxine) in the liver was measured. The content of pyridoxine of irradiated mice decreased and showed minimum value on the 15th day after irradiation (450 R), but the animals treated with PIN 2 mg for 10 days after irradiation exhibited no detectable difference from the value before irradiation. From these results it can be concluded that the administration of significant pyridoxine after irradiation is highly effective in treating irradiation injury with influences on mortality, leukocytes, serum-total protein and A/G ratio, because pyridoxine is an important co-enzyme having a broad effect on the metabolism of protein, and the amount of GOT and pyridoxine content in liver caused by irradiation was maintained at normal level by the administration of pyridoxine. (auth)

6851 RADIOTHERAPY OF METASTASES OF GERMINAL TUMORS OF THE TESTICLE. Ennuyer, A. (Fondation Curie, Paris). Bull. Cancer, 53: 307-28(1966). (In French).

A study was made of results of radiotherapy in cases of malignant seminomas and embryomas of the testicle, especially in relation to lymph node metastases. Techniques and complications of radiotherapy are reviewed. Combinations of surgery and radiotherapy are discussed, and recommendations made as to dose and irradiation field. Four cases are presented and 39 other studies are reviewed, with complications from radiotherapy being discussed extensively. In the cases reviewed 39 patients developed renal postirradiation nephritis. Discrete renal insufficiency occurred in eight cases. Neurological complications, especially radiomyelitis, were found in over 100 cases. In 16 cases gastrointestinal complications occurred after use of supervoltage therapy, whereas in the same study complications were avoided by the use of rotational radiotherapy. Gonadal effects (sterility) were observed in five out of 143 cases, and only five cases out of another 25 produced normal offspring. The average tumor dose recommended is 2500 R over 30 to 40 days for seminoma, unless adenopathy is present, in which case 3000 R is required for the area of lymph adenopathy, over a period of six months. For malignant embryoma a tumor dose of 4500 to 5000 R is recommended, fractionated over 40 to 50 days. (BBB)

6852 THE ENDOCRINE THERAPY OF CERVICAL CANCER: STUDY OF THE EFFECT OF HORMONES ON RADIOSENSITIVITY. Koga, Kohachiro (Kyushu Univ., Fukuoka). Nippon Naibumpi Gakkai Zasshi, 41: 1045-51(Dec. 1965). (In Japanese).

The effect of various hormone treatments on the radiosensitivity of cervical cancer was studied. In radiation therapy combined with estrogen administration, telecobalt γ radiation doses of 6000 R were given from the 2nd to 34th day of the therapeutic period or x rays (20,000 R) from day 2 to 26 and 6000 mg-hr radium from day 29 to 48. Estrogen therapy was conducted at the same time with estradiol monobenzoate, 2 to 4 mg/1 to 2 days for total amounts of 40 mg the 1st to 34th day, or estriol, 2 to 4 mg/1 to 2 days for total amounts of 40 mg. Radiosensitivity was measured on the basis of tissue respiration, glycolysis, Graham's sensitization-response index, radiation-response index (RR), and various clinical observations. Estradiol promoted tissue respiration and

glycolysis in cervical cancer; Q_{O_2}, $Q\dot{C}_{L}$, and $Q\dot{V}_{M_2}$ were increased. In 43 estradiol-administered cases there were 29 (68%) with a good RR and 14 with a poor RR. However, among 29 cases not treated with estrogen there were 11 (38%) showing a good RR and 18 a poor RR. These results suggest the estrogen can promote the radiosensitivity of cervical cancer and have synergistic effect on radiation therapy of cervical cancer. The other results, including disappearance of cancer cells, clinical response, histological finding, and serum lactic dehydrogenase activity also showed a promoting effect of estrogen on the radiosensitivity. (BBB)

6853 LIGHT DERMATOSIS WITH SCAR FORMATION IN CHILDREN. ERYTHROPOETIC PROTOPORPHYRIA AND HYDROA VACCINIFORME. Suurmond, D. (Rijksuniversiteit, Leiden). Ned. Tijdschr. Geneesk., 110: 1485-8(Aug. 20, 1966). (In Dutch).

The effects of uv light (sunlight at wavelengths below 400 nm) on human skin are discussed, with emphasis on protoporphyria photosensitivity. Previous reports in 60 patients with this type of uv skin sensitivity are briefly surveyed, and 2 patients with hypersensitivity to uv light, a girl of 12 and a boy 8 yr of age, leading to redness and swelling, and erosive spots in the nose and between nose and lip in one patient, and small blisters in the second, are described. Lab tests on porphyrin metabolism are reported, and treatment with Contralume cream, containing a benzophenone derivative, was quite successful in the second but only moderately so with the first patient. On the basis of tests it is suggested that hydroa vacciniforme is a complex of symptoms where uv-induced erythropoietic protoporphyria is usually the cause, but occasionally erythropoietic uroporphyria may be underlying, while in other cases no cause has been found. Results of tests with the long-wavelength uv radiation from an Xe high pressure lamp and biopsies of facial tissues from such experiments are described. (BBB)

6854 COMPARATIVE STUDIES ON THE PROTECTIVE ACTION OF CYSTEAMINE (MERCAPTOETHYLAMINE) AND AET (S-2-AMINOETHYLISOTHIURONIUM DIHYDROBROMIDE) AGAINST INTESTINAL IRRADIATION DEATH. Zsebok, Zoltan; Petranyi, Gyozo (Univ., Budapest). Orv. Hetil., 107: 1257-61 (July 3, 1966). (In Hungarian).

The mechanism of protection afforded by cysteamine and AET was studied in rats in the intestinal irradiation death syndrome. As an indicator of Na and fluid metabolism, Na resorption of the small intestine, total and extracellular exchangeable Na content, inulin space, and serum Na concentration were studied. Cysteamine presumably does not exert its effect by decreasing the irradiation injury of the small intestine, but by mobilization of the Na reserves and compensatory increase of the fluid against the Na fluid depletion in intestinal irradiation death. AET apparently cannot correct Na depletion by Na mobilization. Sodium depletion includes not only that of extracellular Na but Na content of the whole body. While AET is capable of compensating for fluid depletion entirely, Na depletion is compensated only to a slight degree. It is emphasized that elucidation of radioprotectant mode of action can only be achieved by a study of their effects on various systems. (BBB)

6855 THE CELLULAR LOCALIZATION OF ^{203}Hg CHLORMERODRIN IN ASTROCYTOMAS. Jackson, George L. (Harrisburg Hospital, Pa. Hahnemann Medical Coll., Philadelphia); Corson, Margaret L.; Dick, Jane. J. Nucl. Med., 8: 611-16(Aug. 1967).

Radioautographic procedures indicate that in two patients with histologically different astrocytomas, radioactive mercury (as Chlormerodrin) was deposited on or within the neoplastic cells. (auth)

6856 ELIMINATION OF MAGNIFICATION ERRORS IN COMPARISON ROENTGENOGRAMS USED WITH RADIOISOTOPE SCANS. Bogardus, C. R. Jr.; Walters, M. G.; Prather, C. E.; Ficken, V. (Univ. of Oklahoma, Oklahoma City). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 101: 585-8(Nov. 1967).

A new four quadrant technique for taking roentgenograms to compare with radioisotope scans is presented. The technique allows more exact superimposition of the roentgenographic silhouette and the radioisotope organ scan outline. This greatly facilitates the radioisotope scan interpretations in heart, lung and liver scans. (auth)

6857 RADIOISOTOPE LIVER SCANS IN PEDIATRICS. Tefft, M. (Harvard Univ., Boston). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 101: 570-84(Nov. 1967).

Selected cases from approximately 250 liver scans in children less than 16 years of age are described. Using this procedure, we have attempted to demonstrate in certain disease states the appearance of the scan, its correlation with either operative or postmortem findings, and its value in the clinical management of some patients. (auth)

6858 APPLICATION OF COLLOIDAL RADIOGOLD AND RADIOIODINATED ROSE BENGAL IN HEPATOBILIARY DISEASE. Rosenthall, Leonard (Montreal General Hospital). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 101: 561-9 (Nov. 1967).

A radioisotope study is described for the evaluation of hepatobiliary disease. The study consists of ^{198}Au retention and liver scans, and radioiodinated rose bengal (RB^{131}I) retention and serial scans of the liver and abdomen. Twenty minute RB^{131}I and 4.5 minute ^{198}Au retentions are given for normals, acute hepatitis, obstructive jaundice, fibrotic liver disease with and without jaundice, acute-congestive heart failure, and liver containing tumor. RB^{131}I retentions greater than 86 per cent indicated polygonal cell disease, whether or not excretion into the intestine was detected. Complete extrahepatic obstruction was present when the RB^{131}I retention was 86 per cent or less, and excretion into the intestine was not observed in the scans of the abdomen. Serial RB^{131}I liver and abdomen scans may exhibit the presence of a dilated biliary tree or nonuniform drainage in the liver, and thus distinguish partial obstruction from hepatocellular disease. An indeterminate group remains that consists of a RB^{131}I retention less than 80 per cent, excretion into the intestine, and a uniform distribution of activity in the liver with ^{198}Au and RB^{131}I. Intra-abdominal bile spill can be diagnosed with serial RB^{131}I scans. The findings in two cases of biliary atresia are described. A three month old infant with biliary atresia showed persistence of RB^{131}I in the liver and no excretion into the intestive which is the usual picture in obstruction, whereas a 2½ year old child showed only a transient appearance of RB^{131}I in the area of the liver and a higher concentration in the kidneys at one and four hours. (auth)

6859 VISUALIZATION OF FILLING DEFECTS IN A LIVER PHANTOM CONTAINING ^{99m}Tc, ^{197}Hg, ^{131}I OR ^{198}Au USING A RECTILINEAR SCANNER OR SCINTILLATION CAMERA. Loken, Merle K; Gerding, Dale (Univ. of Minnesota, Minneapolis). Amer. J. Roentgenol., Radium Ther. Nucl. Med., 101: 551-6(Nov. 1967).

A series of experiments were performed to evaluate the Anger scintillation camera (Nuclear Chicago) and the rectilinear scanner (Picker Magnascanner) as devices for detecting defects in a liver phantom containing a solution of one of the following from radioactive isotopes: ^{99}Tc, ^{197}Hg, ^{131}I, and ^{198}Au. The experimental results are given in detail. (auth)

6860 ^{69m}Zn CHLORIDE, A NEW LIVER SCANNING AGENT. Johnston, Gerald S. (Walter Reed General Hospital, Washington, D. C.); Hupf, Homer, B.; Gotshall, Elizabeth; Kyle, Ralph W. Amer. J. Roentgenol., Radium Ther. Nucl. Med., 101: 548-50 (Nov. 1967).

Following intravenous injection of ^{69}Zn chloride, much of the ^{69}Zn was promptly removed by and concentrated in the liver. Technically good liver scans were obtained using this radioactive agent. The half life and photon energy of ^{69}Zn make it a desirable isotope for clinical work. (auth)

6861 MEDICAL ASPECTS OF ATOMIC WARFARE. I. Krijnen, J. J. Vierde Macht, 15: 59-64(Apr. 1966). (In Dutch).

A nuclear weapon explosion produces three sorts of energy: atmospheric pressure, radiation, and radioactivity. The pressure causes 40% of the injury, heat radiation 60%, and 15% comes from radioactivity. From these percentages, it is evident that a number of persons have more than one type of injury. (tr-auth)

6862 CLINICAL OBSERVATIONS ON THE SHORT TERM EFFECTS OF A SYNTHETIC ANTIBLASTIC SUBSTANCE DERIVED FROM METHYLHYDRAZINE, ASSOCIATED OR OTHERWISE WITH RADIATION THERAPY. Massenti, S.; Perri, G. (Univ., Pisa, Italy). Minerva Radiol., Fisioterap. Radiobiol., 12: 140-4(Apr. 1967). (In Italian).

The immediate therapeutic results obtained in 20 cases of malignant tumors using a synthetic antiblastic derived from methylhydrazine (procarbazine) administered alone or in association with irradiation are reported. No malignant lymphomas were included in the case material. Irradiation was associated with the antiblastic in 7 cases, 5 of them melanoblastomas. Personal opinion is that procarbazine does not have particular advantages, when used alone in daily doses of between 100 and 250 mg up to total doses of 4 to 6 mg, in the treatment of non-lymphomatous epithelial and connectival tumors. Observations in the 5 cases of melanoblastoma treated with the antiblastic and irradiation were more encouraging. Objective remissions were achieved in both the primary tumor and in voluminous metastases without having to use excessively high doses of radiation. It is suggested that

further, systematic clinical experimentation of real long and short-term possibilities of this association should be undertaken. (auth)

6863 OPTIMIZATION OF EXTERNAL RADIATION BEAMS FOR THERAPY PLANNING. Gallagher, Tom Lewis. St. Louis, Washington Univ., 1967. 222p.

Thesis.

There was a constant striving on the part of the radiotherapist to improve his treatment, but it was only recently that a formulation of optimization was proposed that quantifies some parameters in external radiation beam therapy. Because of the complexity of the simulation of radiation beams and of practical optimization schemes, the computer is a necessary tool. The work presented in this dissertation consists of a scheme for the maximization of integral dose in a specified tumor region, subject to a set of constraining conditions in the total treatment area. Optimum levels of source strength are obtained while searching for the levels of angle of beam incidence and wedge filter angle by a perturbation procedure. Optimum plans are given for five anatomical regions, and the results are compared with an initial configuration supplied by the therapists. (Disser. Abstr.) (auth)

Radiation Effects on Animals

Refer also to abstracts 6710–6712, 6714, 6719, 6722, 6730, 6732, 6740, 6744, 6745, 6749, 6750–6753, 6757, 6760, 6768, 6769–6772, 6776, 6780, 6790, 6791, 6823, 6824, 6835, 6836, 6838–6841, 6844, 6847, 6849, 6850, 6853, 6854, 6862, and 6927.

6864 (BNWL-SA-1344) RADIATION SOURCES FOR THE NASA-AMES BIOSATELLITE PROGRAM. Allen, C. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 23, 1967. Contract AT(45-1)-1830. 9p. (CONF-671102-22). Dep. CFSTI.

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

The NASA–Ames Research Laboratory uses γ sources for study of the effects of cosmic radiation and weightlessness in space on the genetics, growth, and development of lower life forms. Gamma sources in the form of stainless steel capsules containing ^{85}Sr are provided in matched pairs, each with an activity of 370 mR/hr/m ± 3%. The ^{85}Sr is obtained from a ^{84}Sr source in the Hanford reactor; ^{85}Sr is discharged from the reactor into a quartz ampoule, which is then crushed underwater in a hot cell; the powder is dissolved; the quartz is filtered off. After precipitation and drying, the powder is loaded into the capsule. A series of testing procedures are carried out (calibration, leak testing, exterior decontamination) prior to shipment of the pair of capsules. (E.R.B.)

6865 (BNWL-SA-1418) ^{90}Sr INDUCED NEOPLASIA IN SWINE. (HEMATOPOIETIC, LYMPHOCYTIC, AND BONE TUMORS IN ^{90}Sr SWINE). Clarke, William J.; Howard, Edwin B.; Hackett, Patricia L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sept. 12, 1967. Contract AT(45-1)-1830. 16p. (CONF-670938-1). Dep. CFSTI.

From Symposium on Delayed Effects of Bone-Seeking Radionuclides, Sun Valley, Idaho.

A total of 718 animals, representing three generations, were exposed to ^{90}Sr feeding levels ranging from 1 to 3100 μCi/day. Two hundred and seventy untreated littermates served as controls. Currently, 128 experimental swine, representing 7 to 10 years exposure, and 63 controls, are being maintained for lifetime observation and study. A total of 53 swine have thus far developed myelo-lymphoproliferative disorders after an accumulative skeletal radiation dose of 300 to 19,000 rads. In addition, five of these animals have shown giant cell tumors or osteogenic sarcomas at bone doses of 8,000 to 14,000 rads. To ascertain whether or not a radiation activated latent virus plays a role in the induction of these disorders, studies are underway to isolate and characterize the particles that have been found in the plasma and cells of some of these animals. (H.L.W.)

6866 (EUR-3553f) NIVEAUX DE CONTAMINATION RADIOACTIVE DU MILIEU AMBIANT ET DE LA CHAINE ALIMENTAIRE. Rapport Annuel 1966. (Radioactive Contamination Levels in the Environment and the Food Chain. Annual Report, 1966). (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct. 1967. 54p. (In French). Dep.

In human biology a special effort was made to determine anatomical data of European man and their evolution with age. The program designed to study the metabolic factors of strontium and their evolution during growth was set up. The estimation of food consumption and of its variation with age, with data from the dietary enquiries carried out in eleven regions, is nearly finished. Some results are available. Investigations on different factors of transfer of radioactive contamination from the polluted environment to food are being continued. Some results were obtained from complementary experimental research. Various mathematical models concerning strontium metabolism were studied. A method of calculating the critical age group from biological and nutritional data and from radioecological factors of transfer were worked out. Finally, a program investigating the distribution network of some of the most important foodstuffs in the six countries of the European Community was initiated. (auth)

6867 (LFEN–56) AS RADIACOES COMO AGENTE SENSIBILIZANTE DA FRAGILIDADE OSMOTICA DOS ERITROCITOS. (Radiation as Sensitizing Agent of Erythrocyte Osmotic Fragility), Galvao, J. P.; Magalhaes, E. M.; Azevedo, N. L. C.; Teixeira, F. P. (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1966. 15p. (In Portuguese). Dep.

Rabbit erythrocytes exposed either in vitro or in vivo to x radiation of 2 MeV produced by a Van de Graaff accelerator verify that they undergo, for doses of the order of 2,000 rad, a stress that is shown by a decrease of total resistance in the presence of a range of hypotonic solutions of sodium chloride. The process can be used to identify in vitro early states of globular fragility. (tr-auth)

6868 (NYO–910–60) CHEMICAL AND BIOLOGICAL STUDIES ON NUCLEIC ACIDS AND DERIVATIVES. Progress Report, April 1, 1966–March 31, 1967. Brown, George B.; Bendich, Aaron (Sloan-Kettering Inst. for Cancer Research, New York). Aug. 15, 1967. Contract AT(30-1)-910. 5p. Dep. CFSTI.

Progress is reported on studies on the biological effects of radiation and related biochemical and physical studies. Emphasis was placed on studies of structures responsible for the carcinogenicity of purines and the effects of irradiation on these structures. Results are reported from studies on the induction of free radicals in dry 7-hydroxyxanthine by uv radiation as measured by electron spin resonance; the identification of products resulting from the γ-radiolysis of guanine; the tumorigenic effects of various doses of the purine N-oxides, 7-hydroxyxanthine and 7-hydroxyguanine on rats; and studies of differences between normal and tumor Chinese hamster cells before and after malignant conversion in vitro by polycyclic hydrocarbon carcinogens or oncogenic viruses. (C.H.)

6869 (USNRDL-TR-67-92) HOMOGRAFT RESPONSE IN ADULT-THYMECTOMIZED MICE: DEFICIENCY WITH AGING AND AFTER LOW DOSE-RATE GAMMA-IRRADIATION. Davis, William E. Jr.; Cole, Leonard J. (Naval Radiological Defense Lab., San Francisco, Calif.). Aug. 4, 1967. 31p.

The homograft response to skin grafts of varying antigenic disparity was measured at 15 to 20 months of age in mice thymectomized at eight weeks of age. The response to male isografts was delayed more in thymectomized female recipients than in intact recipients. Exposure of female mice to sublethal x radiation (at 10 to 11 weeks of age) resulted in a further delay in intact recipients and abrogated the response in the thymectomized recipients. Other intact but aged mice showed a slight impairment of response to skin grafts differing at non-H-2 loci. In thymectomized groups, this impairment was increased. Exposure of both intact or thymectomized mice (at 9 months of age) to 1133 rad of low dose rate γ-radiation (1.4 rad/hr) resulted in an increased delay in response relative to the nonirradiated groups. In all cases, the non-H-2 grafts were the most affected by radiation and thymectomy. It is concluded; after adult thymectomy, the homograft response becomes deficient in old mice, particularly as regards male or non-H-2 isoantigens, and chronic γ-irradiation after thymectomy further increases this deficiency, presumably by creating a greater demand for new immunocompetent cells and/or by eliciting defects in their precursors. (auth)

6870 (NP-tr-1561) HIT REGION THEORY AND LINEAR ENERGY TRANSFER (LET). I. SURVIVAL RATE WITHOUT INFLUENCE OF TIME FACTOR. Guenther, K.; Rossbach, H. Translated by C. L. Carr (Atomic Energy Research Establishment, Harwell, Eng.), from Stud. Biophys., 1: 25-36(1966). 11p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The hit region theory serves to interpret radiobiological experiments in which many similar biological objects are subjected to various doses of ionizing radiation, and the relative number of biological objects not showing a given radiation-reaction represents a characteristic function of the absorbed dose. In its classical form it includes no physical parameters characteristic of the radiation, and serves to interpret single survival curves in a manner largely independent of one another. Survival curves change in general for the same biological ob-

ject with the physical properties and intensity of the radiation. By the inclusion of such parameters in the hit region theory, it should be possible to interpret in a coherent manner groups of survival curves for a given object. The purely biological parameters (hit number, hit region) should remain constant. On the other hand the classical hit region theory always interprets sigmoid survival curves as multi-hit curves and exponential ones as single-hit curves. This interpretation is plausible insofar as at high LET the passage of a particle is considered a hit, while with a low LET it is considered a unit event which is customarily identified with an ionization. These two definitions of a hit correspond to small and large mean distances respectively between the ionizations along the particle paths, in comparison with the dimensions of a radiation-sensitive region. At a high LET one particle passage is sufficient for inactivation; single-hit curves are obtained. At a low LET several particles are required to obtain inactivation, giving multi-hit curves. Only the number of events in the radiation-sensitive region is important for inactivation. The survival rate is based on the probability that a definite number of events occur in the radiation-sensitive volume, and this probability is independent of the absorbed dose and the type of radiation. It is shown that the generalized Blau–Altenburger formula derived by Dittrich can be obtained under very general conditions, for example, in the absence of an idealized hit process. The dependence of the survival rates on the LET is discussed. In general only by taking the time factor into consideration can a maximum of the relative biological effectiveness (RBE) exist as a function of the LET. This is shown by data on the survival of cultured human kidney cells exposed to charged-particle beams of deuterons, protons, helium ions, carbon ions, and oxygen ions. (C.H.)

6871 EFFECT OF LOSS OF BLOOD ON GENERAL REACTIVITY OF THE ORGANISM AFTER IRRADIATION. Karchevskii, A. F.; Filatov, V. F.; Kulik, I. I. Fiziol. Zh., Akad. Nauk Ukr. RSR, 13: 129-31(Jan.-Feb. 1967). (In Ukrainian).

Rabbits that were γ-irradiated to a total dose of 1400 R developed serious radiation sickness with typical changes in the blood picture and general condition. Withdrawal of 25% of the blood volume after the irradiation affected the dynamics of the postirradiation syndrome in the organism but did not prevent the appearance of radiation-damage symptoms. However, replacement of the blood volume with a carbohydrate solution ameliorated and delayed the onset of the symptoms. This was due both to stimulation of erythropoiesis and to mobilization of other protection-compensation reserves, the mechanism of which is not well understood. (TTT)

6872 THYROID ACTIVITY AND RADIOSENSITIVITY RELATIONSHIP IN DIFFERENT VARIETIES OF GOLDFISH, CARASSIUS AURATUS L. Etoh, H.; Srivastava, P. N.; Egami, N. (National Inst. of Radiological Sciences, Chiba, Japan). pp 78-91 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

The relation of thyroid activity and x-radiosensitivity in two varieties of Carassius auratus L., Waken and Demekin, was investigated. Three groups of goldfish, each containing about 20 fish of each variety, were x-irradiated at doses of 1,000, 2,000, and 3,000 R respectively. Thyroid uptake of intraperitoneally injected ^{131}I was measured, and the plasma protein-bound ^{131}I conversion ratio (CR) was established for each variety. Mortality rates and mean survival time of fish irradiated at a dose of 1000 R showed that Demekin was more radiosensitive than Waken; no significant differences were observed at higher doses. The higher radioactivity of the gill region, the higher thyroid uptake factor index, and the significantly higher CR indexes in Demekin suggested greater thyroid activity in this variety. It was concluded that Demekin was the most radiosensitive since the thyroid activity of this variety was higher. (B.H.S.)

6873 ^{60}Co-INDUCED RADIATION CHANGES IN THE UNILATERALLY OVARIECTOMIZED INDIAN DESERT GERBIL MERIONES HURRIANAE JERDON. Srivastava, P. N.; Rao, A. Ramesha (Univ. of Rajasthan, Jaipur, India). pp 373-80 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

The effects of internal γ radiation on the ovaries of the Indian desert gerbil, Meriones hurrianae Jerdon, were investigated. A total of 60 unilaterally ovariectomized females were subcutaneously injected with 10, 20, and 30 μCi of ^{60}Co. Animals were autopsied at intervals of one, two, and four weeks and histological examinations of the ovaries were made; the surgically removed ovaries were examined in the same manner. Complete compensatory hypertrophy (as judged by the ovarian size and the number of maturing follicles) was observed following 10 μCi ^{60}Co administration. The incidence of follicular atresia in the hypertrophied ovaries was not far above the control level; a few maturing follicles displayed accelerated maturation divisions. Females of the 20 μCi group did not deviate much from that of the 10 μCi group; no inhibition was observed in the hypertrophy of the ovaries even after 30 days. However, the rate of atresia of maturing follicles was above the control level. There was considerable reduction in the number of maturing and Graafian follicles in the ovaries of the 30 μCi group, particularly after 30 days. The interstitial cells, germinal epithelium, uterus, and vagina were not affected by any of the three doses. (B.H.S.)

6874 EFFECT OF ^{60}Co INTERNAL IRRADIATION ON THE LIVER OF HETEROPNEUSTES FOSSILIS BLOCH. Srivastava, P. N.; Ram, S. (Univ. of Rajasthan, Jaipur, India). pp 360-72 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

The effects of γ radiation on the liver of Heteropneustes fossilis Bloch were investigated. A total of 180 fish, weighing from nine to 14 gm, were intraperitoneally injected with 5 to 30 μCi of ^{60}Co. Fish injected with physiological saline and nonradioactive $CoCl_2$ served as controls. At doses of 5 and 10 μCi, the greatest hepatic destruction was observed after four to five days, and reparation started on the fifteenth day; an almost normal hepatic picture was seen at 50 days. Doses of 20 and 30 μCi initiated hepatic degradations as early as four hours, and they continued to intensify until the end of the observation period. The only histopathological changes observed in the fish liver that were not similar to those observed in mammalian liver was the formation of giant cells; the mechanism by which the giant cells formed is discussed. (B.H.S.)

6875 BONE MARROW MYELOPOIESIS AND CIRCULATING GRANULOCYTE CHANGES IN THE RAT AFTER INTRAVENOUS INJECTION OF ^{32}P. Nag, B. D.; Lahiri, S. K.; Udupa, K. B.; Chaudhuri, S. C.; Jamdar, S. C. (Saha Inst. of Nuclear Physics, Calcutta). pp 343-56 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

Myelopoietic changes and their connection with changes in circulating granulocytes after intravenous injection of sublethal doses of ^{32}P (1.4 to 4.3 μCi/gm) were investigated in rats. Total and differential leukocyte and bone marrow counts were determined. The method used in determining the mitotic activity of the bone marrow cells is described. After sufficiently high sublethal doses of ^{32}P, a transient granulocytosis in circulation appeared that was followed by a granulocytopenia from which the animals slowly recovered. The rapidity and degree of onset of granulocytosis seemed to be dose-dependent. The granulopoietic behavior of the bone marrow collapsed and the total myeloid count diminished almost to zero at the higher doses in the course of a week; the count was extremely low even at the end of two weeks. The erythroids increased greatly in number and the erythroid-myeloid (E/M) ratio reached abnormal levels. Inhibition of myelopoiesis was ascribed to cell death and arrest of mitosis. From the extremely low value of the E/M ratio, a third cause was indicated; stem cells underwent increased differentiation and this possibly played some role in myelopenia. (B.H.S.)

6876 ERYTHROPOIESIS IN LETHALLY IRRADIATED MICE GRAFTED WITH BONE MARROW OR SPLEEN CELLS. Louwagie, A. C.; Schofield, R.; Lajtha, L. C. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Nature (London), 216: 370-1(Oct. 28, 1967).

The studies described were made during investigations on the influence of drugs on the colony forming capacity of various haemopoietic tissues. Results appeared to disagree with the findings of Kunewick et al. (Nature 213: 302(1967)), who concluded that splenic erythopoiesis in mice lethally irradiated and grafted depends on the source of the grafted cells, the spleens being more erythropoietically active if the animals are grafted with bone marrow as compared with spleen cells; also that the relative erythropoietic activity of the spleen resulting from spleen or bone marrow grafts is not a function of the number of cells administered. In the present studies mice received a total body irradiation of 850R (dose rate 31R/min.). The animals received 5×10^4 bone marrow cells or 5×10^5 spleen cells, derived from the same donor animals. Cell grafting was performed within 2 to 3 hr. of irradiation. Erythropoiesis was assessed by injection of ^{59}Fe on the 7th day, killing of the 10th day, and measuring ^{59}Fe in the blood. The number of spleen colonies was counted under the

dissection microscope. Results are tabulated. The data indicate that by grafting 5×10^4 bone marrow cells or 5×10^3 spleen cells an equal number of haemopoietic colonies is found 10 days after irradiation. Comparing iron utilisation in both groups, however, indicated a higher utilisation in the spleen cell grafted animals. When antibiotics were incorporated in the drinking water a higher iron incorporation was found, irrespective of grafting with bone marrow or spleen cells, but the spleen grafts were always more erythropoietically potent. The difference in erythropoietic activity between the animals grafted with spleen cell and bone marrow is not understood. Mice grafted with spleen cells may have received some immuno-competent cells. (UK)

6877 ACTION OF RADIATION UPON HUMAN SPERMATOGENESIS. Heller, Carl G.; Wootton, Peter; Rowley, Mavis J.; Lalli, Michael F.; Brusca, Donald R. (Pacific Northwest Research Foundation, Seattle). Contract AT(45-1)-1780. Excerpta Med. Int. Congr. Ser., No. 112, 408-10([1966]). (RLO-1780-21).

Graded doses of x radiation administered directly to the human testes evoked graded biological responses in sperm count, testicular morphology, and rate of recovery. Urinary gonadotropin output increased in direct proportion to the degree of denuding of the germinal epithelium. This finding confirms the validity of the Utilization Hypothesis. This hypothesis states that the more active the germinal epithelium the more gonadotropin is utilized and therefore less is excreted in the urine. Conversely, as the germinal epithelium becomes denuded, less germinal cell activity is present, hence less gonadrotropin is utilized and it accumulates and spills over into the urine. This accounts for the rise in urinary gonadotropins. (auth)

6878 STUDIES ON RELATIVE BIOLOGICAL EFFECTIVENESS OF 200-KVP X RAY, ^{60}Co GAMMA RAY, AND 15-MV X RAY ON CULTURED HeLa CELLS. Fujiyoshi, Teruo (Kyushu Univ., Fukuoka). J. Jap. Obstet. Gynecol. Soc. (Engl. Ed.), 14: 29-38 (Jan. 1967).

Determinations of relative biological effectiveness (RBE) of 200-Kv x rays, ^{60}Co γ rays, and 15 MeV x rays from a Betatron were made by using HeLa cells. The cells were exposed to graded doses of radiation (100, 200, 300, 400, 500, and 600 rad). The RBE of ^{60}Co γ rays and 15-MeV x rays were 0.74 and 0.73, respectively, when the RBE of 200-Kv x rays was taken as 1.0, on the basis of cell growth inhibition. In the radiation dose range of 100 to 600 rad, with the RBE of 200-Kv x rays as 1.0, the RBE of ^{60}Co γ rays and 15-MeV x rays depended on the radiation dose; both RBE's decreased with the increase of dose. They also decreased with the increase of culture age. Radiation dose rate differences (9.3 to 35.0 R/min) and cell inoculum variation (1.3×10^4 to 16.4×10^4/ml) did not affect the RBE. A table is given showing RBE's found by other investigators using various criteria. (BBB)

6879 EXPERIMENTAL STUDY ON RADIATION EXPOSURE IN UTERO. III. SUMMARY AND CONCLUSION. Nakagawa, Shigeru (Hiroshima Univ., Japan). Gencho Hiroshima Igaku, 12: 185-7 (Mar.-Apr. 1964). (In Japanese).

Clinical and experimental observations on the effects of radiation exposure in utero on the development of fetuses are summarized. In September, 1959, 64 cases were submitted to uterosalpingography and 14 to fetal x-ray photography, during which dosimetric studies were conducted. The average dose of irradiation for uterosalpingography was 183 mR and for fetuses the doses to the head position were 1036 mR at 10 months' gestation and 1019 mR at nine months' gestation. The average dose to the fetal gonads was about 1 R. By adjustment of the sensitivity of film, the voltage, filtration, and other x-ray photographic conditions the dose of exposure could be reduced. Experiments are also reported in which pregnant mice were x irradiated at different stages of gestation and the offspring, delivered by caesarian section or spontaneously, were examined. The body weight of progeny from irradiated mothers was lower than in the nonirradiated group. In spontaneously delivered fetuses, there was high incidence of stillbirth in irradiated groups and of postnatal mortality. However, the body weight increase of surviving naturally born fetuses from irradiated mothers was not different from that of the nonirradiated fetuses. There was no derangement in hematopoietic function in the fetuses from irradiated mothers. The pregnancy rate of mice mated at 30 to 40 weeks after birth was lowest in progeny from mothers irradiated at 15 days of gestation, as compared to those irradiated at 10 or four days of gestation. (BBB)

6880 SOME ASPECTS OF LASER COAGULATION. Geeraets, Walter J. (Medical Coll. of Virginia, Richmond). Int. Ophthalmol. Clin., 6: 263-73 (Summer 1966).

Effects of laser radiation on the eyes of rabbits and humans were studied histologically, and injury to various ocular tissues in the course of laser treatments was described. The percentage absorption and scatter in human ocular media for light of equal intensity were shown. It was evident that absorption of wavelengths beyond 900 mμ within the ocular media became considerable. This spectral range, therefore, could represent a potential source for ocular media damage. Although reactions of the ocular media were usually negligible, if too high energies were applied ill effects could occur. Complications usually involved the vitreous, with formation of vitreous traction bands. Such vitreous reactions were demonstrated experimentally, even in the very early post treatment phase, when long exposures (1 to 3 min) were used and the retinal irradiance (J/cm^2-sec.) was kept very low so that only very mild retinal reaction occurred. Severe vitreous reactions immediately after exposure in a Dutch rabbit with moderate fundus pigmentation were illustrated. The retinal architecture was well preserved, apparently without marked edema, and the nuclei in both the outer and inner nuclear layers showed stronger staining and slightly fuzzy contours, compared with the sharp outline of adjacent nuclei of the nonirradiated retina. The vitreous overlying the exposed retina consolidated and showed large globules and densities extending for considerable distances peripheral to the irradiated area. Significant electrophoretic changes of the vitreous protein pattern were also observable. The effect of heat conduction within the retina itself was demonstrated by histochemical techniques. Staining of the ellipsoids for DPN diaphorase activity showed inactivation. Although the clinical ophthalmoscopic appearance of the lesion was mild, in histological sections there was extensive edema of all retinal layers, particularly the outer nuclear layer. These observations demonstrated the disadvantage of using intense sources with considerable energy output in a spectral range where the energy was absorbed by structures other than the ones to be treated. By using identical exposure times and other parameters as described, but inserting an IR filter into the light beam, the vitreous reaction was avoided. (BBB)

6881 RADIATION-INDUCED APLASTIC ANEMIA. Cronkite, Eugene P. (Brookhaven National Lab., Upton, N. Y.). Seminars Hematol., 4: 273-7 (July 1967).

Studies pertinent to radiation-induced aplastic anemia reveal that radiation effects are dose-dependent after a single dose of radiation. Radiation acts by killing some hematopoietic cells directly; by producing mitotically connected abnormalities in which the progeny are short lived or can divide only a few times before dying out; and by prolonging the interphase rest. In human bone marrow, all cell lines are affected in a dose-dependent manner. After midlethal doses of radiation, the input of stem cells by differentiation into the diverse cell lines is drastically reduced or may cease. In the case of granulocytopoiesis and megakaryocytopoiesis the differentiated cell lines continue to mature and divide in a relatively uninterrupted fashion. Thus the most immature cells disappear first, followed by successive stages of differentiation and maturation. Lastly, the mature form of the element diminishes in the bone marrow, and this is followed by a diminution in the peripheral blood that is a function of the lifespan of the cell concerned. When the marrow becomes depleted, granulocytes then diminish as a function of their half-time of about 6.6 hr, and platelets with their half-time of about 9 days. Erythroblasts, in contrast to granulocytic and platelet precursors, show considerable direct and prompt killing by radiation. The blood reticulocyte level remains constant for about 24 hr, then diminishes, reflecting the suppression of erythropoiesis. Ten to 20 days after exposure, depending upon dose of radiation, there is an abortive rise in the reticulocyte count for a few days which then diminishes to low values. Again at around 30 days there is a sustained increase in the blood reticulocytes that reflects the sustained regeneration of the bone marrow. Recovery from whole-body and partial-body irradiation is discussed in terms of the fraction of stem cells that survive. (BBB)

6882 EXPERIMENTAL STUDY OF RADIATION EXPOSURE IN UTERO. II. ANIMAL EXPERIMENTS ON FETAL DISTURBANCE FROM IRRADIATION. Nakagawa, Shigeru (Hiroshima Univ.). Gencho Hiroshima Igaku, 12: 161-84 (Mar.-Apr. 1964). (In Japanese).

Pregnant mice were irradiated at various stages of gestation with 180-KV x rays at doses of 120 to 350 rad and some fetuses were delivered by caesarian section at 19 days of gestation, while other fetuses were delivered naturally. The effect of irradiation in utero on the offspring was observed. In the caesarian section group, the average litter size of irradiated mothers was smaller than in the unirradiated group. In the 120-rad irradiated group, the incidence of stillbirths was highest after irradiation on 4 and 9 days of gestation. The incidence rate increased as the dose of irradiation increased. There was no significant difference in radio-induced disorders between male and female progeny. The incidence of abnormal fetuses was higher in the irradiated groups, especially when irradiated from 9 to 15 days of pregnancy. Malformation of

fetuses was observed in the 120-rad group irradiated on the 8th day. In the 200-rad group, malformations were observed when x rays were given between the 8th and 12th day. The incidence of abnormal mouth shapes was the most frequent anomaly in the malformed fetuses (39.8%). The doses inducing 50% abnormal fetuses were found to be 240 rad given at 4 days of gestation (period of organ differentiation in the embryo) and 200 to 350 rad given at 8 to 12 days of gestation (period of organ formation). In the natural birth group, the gestation period for the irradiated groups was longer than in the unirradiated group, and the incidence of stillbirths in irradiated groups was higher. (BBB)

6883 PAINFUL SYNDROME OF POSTRADIATION URINARY-VAGINAL FISTULA. **Graham, John B. (Roswell Park Memorial Inst., Buffalo). Surg. Gynecol. Obstet., 124: 1260-2 (June 1967).**

Development of painful sequelae after radiotherapy for gynecologic cancer is described with reference to ten cases. These patients with urinary-vaginal fistulas who had undergone heavy radiotherapy to the pelvis developed painful lesions of the vagina and vulva associated with crystal formation. At least three of the patients were entirely free of cancer when they experienced the painful syndrome; the fistulas were due to radiation damage. Pain followed the onset of urinary leakage after one to 12 months. One patient had a ureterovaginal fistula and the remainder had vesicovaginal fistulas. Examination of the urine showed an alkaline reaction, protein, crystals, white cells, and bacteria. Triple phosphate, Ca, NH_4, and Mg phosphate crystals occurred as prisms and as star shapes with serrated edges. They were so insoluble that removal by solution was impractical. Histologic section of ulcerated areas revealed plaques of fibrin, leukocytes, and bacteria overlying an inflammatory base. Intact skin showed marked edema of the superficial layers with foci of necrosis and acute inflammation. Bacterial culture of the urine indicated a mixed flora. The sequence of events is viewed as follows. Bacteria in the vagina split urea and other constituents of urine to produce an alkaline medium, and crystals are formed with sharp edges that penetrate the epithelium superficially. Previous exposure to ionizing radiation sensitizes the epithelium so that it is less resistant or more reactive to the trauma. Tissue fluid and leukocytes exude about the crystals, more bacteria accumulate in the area, and more crystals form. Radiation is regarded as an essential predisposing agent because all ten patients had received irradiation, and this condition was not seen in unirradiated patients. (BBB)

6884 EXPERIMENTAL GENETIC AND PATHOLOGIC STUDIES OF IRRADIATION UPON FERTILITY AND OFFSPRING OF MICE. **Ota, Akira (Hiroshima Univ.). Gencho Hiroshima Igaku, 12: 103-15 (Mar.-Apr. 1964). (In Japanese).**

The effects of x-ray, neutron, and ^{137}Cs γ irradiation on fertility and development of the mouse fetus were studied. In the first experiment, the ddN strain mice, 12 weeks of age and about 25 g in body weight, were divided into three groups and various doses of radiation were given to female mice at four, ten, and 15 days of pregnancy. X rays were given at doses of 120 and 200 rad, neutrons at a dose of 30 rad, or ^{137}Cs γ radiation at doses of 60 and 120 rad. In the second experiment, the progeny from irradiated mothers were mated with the progeny from nonirradiated mothers and development of the second generation was observed. The mating groups included male and female progeny of irradiated mothers, females from irradiated mothers and nonirradiated males, and males from irradiated mothers, and nonirradiated females. The F_1 and F_2 generations also received various doses of x-ray, neutron, and ^{137}Cs γ irradiation and the effect on the pregnancy rate was observed. In general, the results of irradiation of pregnant females showed that there was no significant difference in body weight of their offspring from that of nonirradiated controls. Malformations were not observed in the offspring of irradiated mothers, but fertility was low in both male and female progeny of irradiated mothers. (BBB)

6885 THE EFFECT OF X RAYS ON THE DEMOGRAPHIC CHARACTERISTICS OF PHYSA ACUTE (GASTROPODA: BASOMMATOPHORA). **Ravera, O. (EURATOM, Ispra, Italy). Malacologia, 5: 95-109 (June 1967).**

The effects of irradiation on the demographic characteristics of a common freshwater snail were determined by measuring mortality, fecundity, and fertility rates of the adult and viability of the eggs. The adults were exposed to 300-KV x rays at doses ranging between 2 and 220 KR. The dose rate ranged between 1 and 2 KR/min. In comparison with the controls, the mortality of animals irradiated at 10 KR was similar; at 54 KR, it did not significantly differ until 20 days after irradiation; at 100 KR, it rose to 95% on the 18th day; all snails were killed in one day by 220 KR. Production of egg-capsules and the number of eggs they contained were reduced by irradiation, but not greatly, up to 10 KR. A dose of 2 KR reduced viability and fertility. Recovery of germ tissue was noted in individuals irradiated with 2 and 10 KR. Maintenance at higher temperature increased the effect of irradiation on the reproductive processes of adults to a greater extent than it did on survival. (BBB)

6886 SURVIVAL OF POLYCYTHEMIA VERA PATIENTS TREATED WITH RADIOACTIVE PHOSPHORUS. **Harman, J. B. (Royal Marsden Hospital, London); Ledlie, E. M. Brit. Med. J., 1: 146-8 (Apr. 15, 1967).**

Incidence of leukemia, bone-marrow failure, and other radiation-implicated causes of death was evaluated in 132 patients treated with ^{32}P. Data were compared with that of an earlier series before use of radiophosphorus in this disease. Ten deaths were attributed to leukemia, a considerably higher incidence than in control cases or normal subjects, suggesting a causal relation with ^{32}P. There were 65 deaths among the 132 polycythemic patients treated with radiophosphorus. Radiophosphorus-treated patients did not live as long as normal persons, but they lived longer than the control patients. Radiophosphorus increased the incidence of death from marrow failure, but there was no evidence that patients dying from marrow failure died sooner than those who died from other causes. Twenty-two of the 65 dead patients died of some kind of marrow failure. Anemia was a constant feature of these cases, and gross disturbance of granuiocyte and platelet production was common. Some of these patients developed changes characteristic of aplasia or myelosclerosis, but a more usual finding was the appearance of immature white cells and often leucoblastosis in the blood or marrow. In about a fifth of these cases the marrow failure was acute, lasting a matter of months. (BBB)

6887 DIAGNOSIS OF SIGMOIDOVAGINAL FISTULA BY VAGINOGRAM: REPORT OF 2 CASES. **Tancer, M. Leon; Zahiruddin, Salma (French Hospital, N. Y.). Obstet. Gynecol., 28: 815-19 (Dec. 1966).**

Two cases of sigmoidovaginal fistula are described, one as a result of radiation injury. The 53-yr-old patient had received radiotherapy two yr earlier following curettage and a diagnosis of endometrial carcinoma. The uterus had been packed (Heymann technic) with 75 mg of Ra for a total dose of 7125 mg/hr. Abdominal total hysterectomy and bilateral salpingo-oophorectomy were performed six weeks later. At that time it was noted that the left adnexa were adherent to the sigmoid. The right adnexa were dissected from the right lateral pelvic wall with great difficulty. Three months later vaginal leakage of urine was noted and a ureterovaginal fistula was diagnosed. One month later severe vaginal and intra-abdominal hemorrhage occurred, necessitating an emergency laparotomy. After surgery a right ureteroabdominal fistula resulted, and an enterostomy was performed three months later because of acute small-bowel obstruction. A right cutaneous ureterostomy was performed two months later. Methods for diagnosing sigmoidovaginal fistulas are discussed. (BBB)

6888 CANCER OF THE VAGINA. **Rutledge, Felix (M. D. Anderson Hospital, Houston, Tex.). Amer. J. Obstet. Gynecol., 97: 635-55 (Mar. 1, 1967).**

Techniques, results, and complications of radiotherapy are reported with reference to 101 patients. Intravaginal Ra is particularly suited for use in vaginal cancer because the dose can be delivered to diseased tissue without first traversing normal tissue, and a much higher dose can be delivered to a localized area with greater protection of the normal tissues than with external radiation. Radium sources were arranged so as to deliver an average dose of 7000 R or up to 10,000 R if two insertions were used. X-ray therapy was usually given to the pathways of spread into the parametrium and pelvic wall area. High-dose irradiation with supervoltage apparatus was required for the more advanced lesions because of the depth of spread and the tumor bulk. Tissue necrosis from high intensity irradiation occurred in some instances. Although the dosimetry of Ra applications may be accurate, the individual response is not predictable. The most common site for necrosis was in an ulcer in the region of the primary lesion. Some of the necrosis was the result of destruction of cancerous tissue, but normal tissue may also be destroyed. These ulcerated necrotic areas were slow to heal and some caused discomfort for many months or even years following treatment. If the slough occurred in the base near the bladder or rectum, a fistula often resulted, but if no fistula developed, these areas eventually healed by scar formation. (BBB)

6889 COMPARATIVE MECHANISM OF SPONTANEOUS LEUKEMOGENESIS OF C57BL MICE. **Duplan, J. F. (Fondation Curie, Paris). Rev. Roum. Med. Interne, 4: 147-58 (1967). (In French).**

A comparative study was made of the action of x irradiation on spontaneous leukemogenesis in AKR mice and radioleukemogenesis in C57BL mice. Incidence of lymphosarcomatosis in normal AKR mice is 80 to 90%; that in C57BL mice is 7% normally and 80 to

95% when they are irradiated. Irradiation in this experiment was given at 225 KV at a dose rate of 100 R/min. Mice were placed in plastic boxes in groups of eight. Isogenic or allogenic injections of bone marrow or fetal liver were made to determine the role in leukemogenesis of the lymphoid regeneration process and of the abilities of different strains of cells to become lymphosarcomatous. It appeared that lymphopoiesis and regeneration were natively deficient in AKR mice and normal in C57BL mice. It was shown that in radiochimeras (AKR-C3H and AKR-C58) the ability of cells of allogenic strains to be transformed into leukemic cells by the leukemogenic AKR virus depended not only on host (AKR) factors but also on genetic characteristics of the grafted cells themselves. A leukemogenic virus was demonstrated to be present in nonleukemic nonirradiated C57BL mice. The low rate of spontaneous leukemia in this strain was explained by the fact that target cells, as well as the leukemogenic virus, are present at a very low level in normal C57BL mice. (BBB)

6890 HODGKIN'S DISEASE TERMINATING IN CHRONIC MYELOID LEUKEMIA. Johnson, F. Deborah; Jacobs, Edwin M.; Wood, David A. (Univ. of California, San Francisco). Calif. Med., 104: 479-84(June 1966).

A presumptive case of radioinduced chronic myeloid leukemia is described. A patient with Hodgkin's disease was treated with high-dose x radiation therapy, and after 7½ yr of satisfactory control, leukemia developed. A tumor dose of 1000 R had been given to the mediastinum and a tissue dose of 1500 R to the left axilla. Follow-up examinations showed progressive decrease in adenopathy. About 1 yr later an enlarged supraclavicular node was noted; 1000 R of x rays was given and the node promptly disappeared. A right cervical adenopathy appeared and also responded to radiation therapy. Radiation therapy was given to the right axilla and to the mediastinum 5 yr later. Seven yr after initial treatment, leukocytes numbered 18,500 per mm^3 and later progressively increased. The patient showed radiation erythema over the chest, back, arms, and neck. The patient had received over a 6-yr period 138 treatments with 250-KV x rays, giving a total skin dose of 28,500 R. It is suggested that the terminal illness was due to cumulative effects of radiation therapy rather than to a spontaneous occurrence of leukemia. The development of myeloid leukemia in patients with Hodgkin's disease who have not received irradiation is so rare that it can be considered fortuitous. Both the literature and the present case suggest that myeloid leukemia in paients with Hodgkin's disease is related to therapeutic exposure to radiation. Although radiation is curative in localized Hodgkin's disease and the treatment of choice initially, discretion should be used in the total amount administered. (BBB)

6891 ULTRAVIOLET RADIATION AND FLUORESCENCE IN DIAGNOSIS, THERAPY, AND RESEARCH: A REVIEW OF THE LITERATURE WITH SPECIAL REFERENCE TO THREE FLUORESCENT DYES. Christen, Arden G. (Lackland Air Force Base, Tex.). J. Oral Ther. Pharmacol., 3: 62-79(July 1966).

Biological effects of uv radiation, particularly on the eyes and skin, are reviewed (74 references), as well as use of uv radiation in dental therapy and research, and uv interaction with fluorescent dyes. Damage to the eyes from an overdose of uv radiation is described. The symptoms include light intolerance, excessive lacrimal secretion, lid smarting and swelling, pupillary contraction, and development of ulcers on the eyeball or cornea. However, these lesions are usually superficial, for the cornea absorbs all radiation below 3000 Å and the lens reacts similarly to those rays below 3500 Å; thus, the retina is protected. In some cases, blindness may even result, but recovery usually takes place within a few days. The skin reaction depends upon the wavelength of and the duration of exposure to uv radiation. Only the first 1 to 2 mm of tissue absorbs uv radiation. Ultraviolet radiation, in at least some susceptible persons, is definitely carcinogenic. Certain outdoor occupations increase the risk of skin cancer in fair-skinned people. After exposure to radiation in the range of 2900 to 3100 Å, the skin becomes red and blisters. At 3900 Å, darkening of the skin occurs as a result of the oxidation of preformed melanin. (BBB)

6892 INCREASED RADIOSENSITIVITY WITH INACTIVATION OF THE LABYRINTH; PROBLEM OF SPACE FLIGHT RADIATION SAFETY. Arlashchenko, N. I. Radiobiologiya, 7: 350-6(1967). (In Russian).

Experiments were performed on labyrinthectomized male rabbits weighing 3.5 to 4.0 kg to determine the significance of vestibular disturbance in radiation injury. Following bilateral, unilateral, and false (without injury to inner ear) labyrinthectomies, animals were gamma-irradiated (EGO-2 unit, 176 R/min) with a single 650 R dose, after 15 min, one day, and 25 days. Survival of animals was determined for a 30 day period. Data show that the intensity of radiation injury of labyrinthectomized animals depends on the degree of neutral shifts resulting from vestibular disturbance. With irradiation of intact or labyrinthectomized animals surviving a 25 day period, the death rate was 60%. However, with irradiation of labyrinthectomized animals shortly after the operation, the period of highest vestibular disturbance, the death rate was 100%. It was concluded that as long as the vestibular functional disturbance is comparable to weightlessness under spaceflight conditions, a general increase in radiosensitivity can be expected. (ATD)

6893 CYCTOLOGICAL ANALYSIS OF CHIMAERISM IN RATS IRRADIATED DURING FOETAL LIFE. Matosic, M.; Keckes, S.; Allegretti, N. (Univ. of Zagreb). Nature (London), 216: 371-2(Oct. 28, 1967).

It was found that adult rats irradiated during foetal life showed specific tolerance of maternal skin graft, and that the degree of tolerance was proportional to the irradiation dose. These results are interpreted as being caused by the passage of maternal blood cells through the placenta into the foetus. It was desirable to ascertain whether maternal cells do, in fact, proliferate in rats irradiated during foetal life. The sex of the rat karyotype is easily identified, and this marker was used in male progenies for identification of the mother's cells in bone marrow. Pregnant females were X-irradiated to 100, 200 and 400 R at 80 to 85 R/min. Chromosome preparations of the bone marrow of 1 to 2 months' old males, irradiated at between 16 and 20 days of foetal life, were made, and the arrangement of chromosome pairs, with subsequent determination of the sex of the individual karyogram, was investigated. Results are tabulated, and indicate that the percentage of female cells in the bone marrow of male progeny irradiated during foetal life was proportional to the irradiation dose. The increase in the percentage of maternal cells in irradiated male progeny corresponded well with the increased tolerance after larger irradiation doses. (UK)

6894 PROTECTION OF CANINE PANCREATIC ULTRASTRUCTURE AGAINST RADIATION DAMAGE BY POST-TREATMENT WITH ALLOXAN. Wellmann, K. F.; Volk, B. W.; Lazarus, S. S. (Jewish Chronic Disease Hospital, Brooklyn). Nature (London), 216: 86-7(Oct. 7, 1967).

In non-alloxanized dogs irradiation of the exteriorized pancreatic remnant with a single large dose of roentgen rays (5,000 to 9,000 R), after partial surgical pancreatectomy, produced extensive cellular damage, together with a marked reduction in activity of pancreatic tissue enzymes. After pre-treatment with alloxan, however, ultrastructural alterations were not observed, apart from occasional minor lesions, although the effects on the enzymes remained. Dogs given alloxan several days after irradiation were also examined, together with animals receiving alloxan both before and after irradiation. Examination of the alloxan-treated animals with an electron microscope revealed no extensive cytological alterations. It is concluded that alloxan arrests many otherwise observable post-irradiation changes of the cytoplasm of the canine pancreas, even when administered as late as one or two weeks after irradiation. The observations are in keeping with findings that mice receiving alloxan within a few hours of exposure to x rays showed a reduced mortality level. The mechanism for the radioprotective action of alloxan is not known, but it may be that interaction with amino-acids causes structural modifications and reduces the synthesis of proteins, and particularly those with free amino-acid groups or -SH radicals. (UK)

6895 EFFECT OF ULTRA-VIOLET RADIATION ON SKIN COLLAGEN OF INTACT LIVING MICE. Shuster, S.; Bottoms, E. (Royal Victoria Infirmary, Newcastle-upon-Tyne, Eng.). Nature (London), 214: 599-600(May 6, 1967).

It has been shown that the ageing of exposed skin is associated with a decrease in total collagen content. Ageing collagen shows decreased solubility, and it has been found that when skin from hairless mice is exposed to uv radiation in vitro there is a decrease in soluble collagen fractions, together with an increase in intermolecular crosslinkage. The present communication describes an investigation to ascertain whether uv radiation produces these effects in the intact living animal. After the irradiation the dorsal skin was erythematous and oedematous, and there was a marked decrease in the saline and citrate soluble collagen fractions, but no effect on the much larger amounts of insoluble collagen. (UK)

6896 RADIATION HAZARD IN RADIOGRAPHY OF THE FEMALE ABDOMEN AND PELVIS. Reekie, D.; Davison, M.; Davidson, J. K. (Southern General Hospital, Glasgow). Brit. J. Radiol., 40: 849-54(Nov. 1967).

The International Commission on Radiological Protection (1964) has recommended that all radiological examination of the lower abdomen and pelvis in women of reproductive age be limited where possible, to the ten day interval following the onset of menstruation. This is not incorporated in the British Code of Practice (1964). It

is also recommended by the I.C.R.P. and the British Code of Practice that for designated persons the abdominal dose should not exceed 1.3 rads in any 13 week period and that the dose to the fetus should not exceed 1 rad during the known period of pregnancy. The somatic hazard to the fetus from 1 rad can lead to a risk of one in 5,000 of subsequently developing cancer, or approximately doubles the natural risk of dying from some form of cancer at an early age. The genetic hazard is much less, but one rad will increase the natural mutation by three percent. The actual radiation exposure given to patients in a large general hospital for various radiographic investigations of the abdomen was measured. The gonad and fetal doses were obtained by calculation of the relevant depth doses taking the most probable position of the ovaries before and during pregnancy and of the fetus at term. The results show that in early pregnancy the embryo may receive approximately one rad in lateral radiographs of the lumbar spine and of the lumbo-sacral junction, in renal arteriography and similar examinations requiring multiple exposures, and in all screening examinations of the pelvis and lower abdomen. Even with a repeat radiograph, none of the other projections seems likely to lead to a serious hazard. It is highly unlikely that, under existing practice, these or other abdominal examinations would be carried out on pregnant women unless there were clearcut clinical indications. It is suggested that examination of the lumbar spine, examinations requiring multiple exposures of the lower abdomen, and all screening examinations of the pelvis and lower abdomen be limited to the ten day interval following the onset of menstruation. (auth)

6897 THERMIC INFLAMMATION IN ACUTE RADIATION SICKNESS. Romanovskaya, L. L.; Dorofeev, V. M.; Koroleva, L. V. (Obninsk Inst. of Medical Radiology, USSR). Byull. Eksp. Biol. Med., 64: 31-4(Oct. 1967). (In Russian).

The features peculiar to the exudative phase of the thermic inflammation in acute radiation sickness were studied. Methods permitting quantitative measurement of the intensity of inflammation (weight of the burned limb and radiometric measurement of the thickness of the burned ear) were used. Rats of the August and Wistar strains were employed. It was found that edema in acute radiation sickness is inhibited, and the degree of inhibition depends on the stage of radiation sickness (more marked on the 3rd, 14th, and 21st days). It was likewise found that the intensity of the edema depends on the area of the lesion and the animal strain. (auth)

6898 ACUTE LEUKEMIA IN GUINEA PIGS IN REMOTE PERIODS FOLLOWING CHRONIC IRRADIATION. Belousova, O. I.; Strel'tsova, V. N. Byull. Eksp. Biol. Med., 64, 85-7 (Sept. 1967). (In Russian).

Acute leukemia developed in five guinea pigs out of 40 that survived after chronic x irradiation. Acute leukemia developed in all the animals five to six months after the end of irradiation. Cessation of differentiation of the erythropoietic cells at the stage of reticular cells and hemocytoblast occurred. (auth)

6899 SKIN SENSITIVITY TO ULTRAVIOLET IRRADIATION IN PERSONS WORKING IN THE OPEN AIR AND IN CLOSED PREMISES. Nikolaeva, E. N. Gig. Sanit., 7: 27-31(July 1967). (In Russian).

The time necessary for the development of erythema as the result of doses of ultraviolet irradiation with a lamp, placed at a distance of 0.5 m in summer and in winter among persons (builders) working in the open air all year round, and among the workers of a mechanical work shop was determined. The skin sensitivity to uv light was found to be higher (by 28.5% in summer and by 36.6% in winter) in persons working in closed premises than in the builders. The time of uv irradiation necessary for the development of erythema in 46% of mechanical shop workers amounted to 1 min. (auth)

6900 INHIBITION OF STRONTIUM AND CALCIUM UPTAKE BY RAT DUODENAL SLICES: COMPARISON OF POLYURONIDES AND RELATED SUBSTANCES. Patrick, G. (Medical Research Council, Harwell, Eng.). Nature (London), 216: 815-16(Nov. 25, 1967).

It has been established that intestinal absorption of Sr is inhibited by sodium alginate taken orally, both in rat and in man, while Ca absorption is not significantly reduced. Alginic acid is a polyuronide composed of l-guluronic and d-mannuronic acid residues; both acids can occur in the same uronide chain. Polygalacturonic acid has also been found to inhibit Sr absorption more than that of Ca, when given to rats by stomach tube. In the study described the uptake of ^{85}Sr and ^{45}Ca by slices of rat duodenum incubated in vitro was measured in the presence of sodium alginate containing guluronic acid, polygalacturonic acid, and pectin; also in the presence of oxycelluloses containing high proportions of uronic acid groups, and in the presence of oxidised amyloses. Experimental details are outlined, and results are tabulated. Sr uptake was not inhibited more than Ca uptake by addition of polygalacturonic acid or pectin. The oxycelluloses varied in their effect. The oxidised amyloses all inhibited Sr and Ca uptake to a limited extent, but did not reduce Sr more than Ca. Inhibition of Sr uptake relative to Ca was increased with increasing guluronic acid content in sodium alginate. It is concluded that the selective inhibition of Sr uptake by alginates is produced by the guluronic acid residues which they contain. Polygalacturonate reduced uptake of Ca and Sr about equally, in contrast with the greater inhibition of Sr observed in vivo. Of all the substances investigated only sodium alginate inhibited Sr uptake more than Ca in vitro. The explanation is presumed to reside in the configurations, and particular disposition of functional groups, such as carboxyl, in the various polyuronides, and particularly in polyguluronic acid. (UK)

6901 RADIATION SENSITIVITY AND PROLIFERATIVE RECOVERY OF HEMOPOIETIC STEM CELLS IN WEANLING AS COMPARED TO ADULT MICE. Fred, Sallie S.; Smith, Willie W. (National Cancer Inst., Bethesda, Md.). Radiat. Res., 32: 314-26(1967).

Effects of γ-radiation on survival and proliferation of stem cells were compared in weanling and adult mice, and the observed differences related to the differences in granulocyte count and 30-day LD_{50}. Colony-forming units (CFU) of both spleen and femur were more radiosensitive in weanlings. In nonirradiated weanlings the number of CFU in the spleen was greater than in adults, so that after irradiation the numbers were approximately the same in both. Endogenous spleen colony counts were also the same in the two age groups given the same radiation dose, although mortality was higher in the weanlings. In the femur there were fewer CFU initially as well as a lower percentage survival, that resulted in the weanlings having less than half as many CFU as adults after irradiation. Granulocytic areas were rare in the recovering spleen but numerous in the femur. Thus, the greater damage to bone marrow, rather than to spleen, was probably responsible for the lower postirradiation granulocyte counts in weanlings. There was no difference in the pattern of proliferative recovery of surviving CFU of weanlings and adults. The principal difference in damage affecting survival was therefore in the death of marrow stem cells. Extrapolating from the dose range studied, this would account for approximately half of the difference in 30-day LD_{50}. (auth)

6902 RECOVERY AND REPOPULATION IN VIVO BY MOUSE SKIN EPITHELIAL CELLS DURING FRACTIONATED IRRADIATION. Withers, H. R. (Mt. Vernon Hospital, Norwood, Eng.). Radiat. Res., 32: 227-39(1967).

The dose survival and regeneration characteristics of irradiated mouse skin epithelial cells were studied using an in situ, in vivo cell cloning technique. The cells surviving a first dose of x-rays are characterized 24 hours later by a survival curve having the same slope as that for cells not previously irradiated. The value for $(D_2-D_1)_{24hr}$ was about 350 to 375 rads. The value of (D_2-D_1) increased by an average of about 100 rads per day with extension of fractionation intervals from one to six days. At intervals of less than 24 hours, a typical fluctuating pattern of recovery was observed. It is postulated that some repopulation by surviving cells occurs within 24 hours of a first dose of less than 800 rads and that this proceeds in the five days thereafter with a doubling time for the clonogenic population of approximately 22 hours. Evidence is presented for the differentiation of about 25% of each generation of cells during rapid re-epithelialization. (auth)

6903 CELL PROLIFERATION STUDIES IN THE INTESTINAL EPITHELIUM OF THE RAT: RESPONSE TO CONTINUOUS IRRADIATION. Cairnie, A. B. (Inst. of Cancer Research, Surrey, Eng.). Radiat. Res., 32: 240-64(1967).

A proliferative steady state is established in the rat jejunum within two to three days of commencing whole-body irradiation at 350 rads/day with ^{137}Cs γ rays. The parameters measured in this study were the labeling and mitotic indices of cells in various parts of the crypt at frequent intervals after starting irradiation and during recovery; also the proliferative cell cycle and turnover time of mature cells after five days of irradiation. It was concluded that the cell cycle starts to lengthen within six hours of starting irradiation, reverse this trend after a day, and is finally shorter than normal. From the disparity between the labeling index and cell cycle data in the lower part of the crypt after five days, it was deduced that about 38% of the cells there are sterilized by radiation but quite possibly able to differentiate. Within six hours of ceasing irradiation an increase in labeling index occurs that denotes rapid initiation of recovery by unknown mechanisms. It is proposed that intestinal cells have a greater ability than bone marrow cells to repair low LET damage, that would account for much of the difference in radiosensitivity of these tissues under continuous irradiation. (auth)

6904 PATHOMORPHOLOGY OF THE LIVER IN EXPERIMENTALLY INDUCED RADIATION SICKNESS IN RABBITS. Szczurek, Zbigniew (Inst. for Pathological Anatomy, Zagreb). Int. Arch. Gewerbepathol. Gewerbehyg., 23: 19-31(1967). (In German).

Sublethal doses of whole-body x irradiation ranging from 200 to 1000 R were administered to adult rabbits. Studies of the liver demonstrated by the second day postirradiation regressive changes, including vascular and parenchymal degeneration, focal granulation, and scattered foci of coagulation necrosis. These changes involved the liver cells and the epithelium of the small bile ducts. Their severity was related to the irradiation dose administered, and except for the necroses tended to decrease in extent with time. Fatty degeneration was observed during the first days after irradiation. Circulatory impairments observed included hematomas and hyaline thromboses, and less frequently blood effusions. Soon after the higher irradiation doses, vascular edema and endothelial hyperplasia along with stromal and interstitial hyperplasia, and stromal and interstitial edema were observed. Progressive changes observed included a moderate increase in stromal connective tissue, focal thickening of vascular walls, endothelial hyperplasia, granulation, and leucocytic infiltration. Glycogen concentrations were decreased inversely with the irradiation dose given. (BBB)

6905 INITIAL REACTIONS OF THE VESTIBULAR ANALYZER OF RABBITS WITH LOCAL IRRADIATION. Nesterenko, V. S. Radiobiologiya, 7: 429-32(1967). (In Russian).

Direct and indirect effects of local irradiation on vestibular analyzer function were investigated in relation to Coriolis acceleration in four experimental series on rabbits. The animals were x-irradiated locally (RUM-3 unit, 180 kv, 15 mamp, 0.5-mm Cu and 1-mm Al filter, 30-cm focal length, 56 R/min) with a single 800 R dose in all the series. In the first series, a part of the stomach was irradiated to determine the reflected effect; in the second series, the whole head was irradiated to determine the direct effect of irradiation on the reflex arc of the vestibular somatic reflex; in the third series, the craniocerebral area of the head was irradiated to determine the direct effect on the central nervous system in general and the vestibular analyzer in particular; and in the fourth series, a part of the face excluding the brain tissue was irradiated to compare with the effects of the third series. Vestibular-analyzer sensitivity was evaluated by reactions to Coriolis acceleration before and after irradiation. Irradiation of the stomach area, head, and facial areas reduces vestibular-analyzer function within the first five hr. But, with irradiation of the craniocerebral area, vestibular-analyzer function is increased within the first two hr and is slightly depressed by the fifth hr. The data show that only the direct effect of local irradiation of the brain increases vestibular-analyzer function, and the indirect effects of local irradiation induce depression of vestibular-analyzer function. (ATD)

6906 EFFECT OF GAMMA RADIATION ON THE LARVAE AND THE NUCLEAR-POLYHEDROSIS VIRUS OF THE EASTERN TENT CATERPILLAR MALACOSOMA AMERICANUM. Smirnoff, W. A. (Forest Research Lab., Sillery, Can.). J. Invertebr. Pathol., 9: 264-6(1967).

The effects of ^{60}Co γ radiation were studied on larvae of Malacosoma americanum with and without the nuclear-polyhedrosis virus, and on the lyophilized polyhedra. Larvae and some lyophilized polyhedra were exposed to doses of 10,000, 50,000, 100,000, 150,000, 200,000, and 300,000 RAD. Other polyhedra were exposed to 500,000, 800,000, and 2,000,000 RAD. Treatment at 100,000 RAD resulted in complete mortality after 10 to 12 days and at 300,000 RAD after 48 hr. Doses of 10,000 and 50,000 RAD seemed to have no effect on the larvae. Mortality caused by virus was accelerated in virus-infected larvae irradiated with doses of 10,000 and 50,000 RAD; they died after 11 to 12 days while nonirradiated infected larvae died after 14 to 16 days. However, at 100,000 RAD the period of mortality was the same for larvae with and without virus infection. Irradiation of dried polyhedra at 10,000 RAD accelerated development of virus disease, particularly in third instar. Irradiation of the polyhedra at 300,000 and 500,000 RAD did not noticeably influence mortality caused by virus. Irradiation of polyhedra at 800,000 RAD reduced the effect of the virus, while irradiation at 2,000,000 RAD completely inactivated the polyhedra. (BBB)

6907 EFFECTS OF GAMMA RADIATION (^{60}Co) ON MORTALITY AND MALFORMATIONS IN CHICK EMBRYOS. Knezevic, Zoran; Karanovic, Jovo Bull. Boris Kidric Inst. Nucl. Sci., 17: 317-28(Oct. 1966).

White leghorn embryos irradiated with 700 R of gamma rays at a rate of 50 R/min have different mortality rates depending on their age at the moment of irradiation. Embryos of different ages were irradiated, starting with the preincubation period up to 10 days of age inclusive. The mortality rate increased with age, it was highest in embryos aged 7 to 9 days. There are also teratogenic periods for some organs, associated with the critical development period of these organs, as shown by some specific malformations. (auth)

6908 LATE CHANGES IN PERIPHERAL BLOOD AFTER THOROTRAST ADMINISTRATION. Langlands, A. O.; Williamson, E. R. D. (Western General Hospital, Edinburgh). Brit. Med. J., 2: 206-8(July 22, 1967).

Hematologic tests were conducted on 37 patients, survivors among 137 subjects who received Thorotrast intraarterially in an Edinburgh clinic from 1930 to 1947. In all 35 patients the packed cell volume, hemoglobin level, white cell count, and platelet count were within the normal range. A few patients showed a relative lymphocytosis, but the mean values for the differential white cell count did not differ significantly from the normal. The most striking feature on examination of peripheral blood films was a disturbance of red cell morphology. There was a varying degree of anisocytosis, with occasional well-filled macrocytes; numerous burr cells and occasional target cells and stipple cells were present. Giant platelets were common. Howell–Jolly bodies were present in 34 out of 35 films, the exception being that of a woman of 55 who, 23 yr previously, had received 40 ml of Thorotrast during right carotid angiography. In her neck a hard mass was found at the site of injection, x-ray films showing this to be a dense aggregation of Thorotrast. No Thorotrast was visible in the spleen on abdominal x-ray examination. The presence of Howell–Jolly bodies in erythrocytes is usually associated with removal of the spleen. Evidently a progressive loss of splenic function occurred in these patients as a result of irradiation and this caused the peripheral blood changes described. (BBB)

6909 PROTEUS MIRABILIS ENTEROCOLITIS FOLLOWING ABDOMINAL IRRADIATION: REPORT OF A CASE. Van Woert, Melvin H. (Oak Ridge Inst. for Nuclear Studies, Tenn.). Amer. J. Dig. Dis., 12: 737-41(July 1967).

The case is reported of an adult patient who developed Proteus mirabilis enterocolitis following abdominal irradiation for metastatic carcinoma. For a serous cystadenocarcinoma involving the left ovary and fallopian tube, the patient was started on a 4-week course of abdominal irradiation with ^{60}Co. Irradiation was given five times weekly for the first 2 weeks, then three times weekly by four 15 × 15 cm. portals to the right and left anterior and posterior pelvis. The total skin dose from each portal was 2420 R (tumor dose 1345 R). After 2½ weeks of radiation therapy, the patient developed nausea and 1 week later, vomiting and diarrhea. These symptoms gradually became more severe. Proteus mirabilis (sensitive to nalidixic acid in vitro) was isolated from stool cultures as the predominating organism. Administration of nalidixic acid, 1 g 4 times a day orally, was begun and continued for 10 days. Within 36 hr the patient became afebrile, and the abdominal distention, diarrhea, and vomiting subsided. The case circumstantially implicates intestinal irradiation as a probable contributing factor in the overgrowth of Proteus organisms in the gut. Supporting evidence for this was obtained from animal experimentation, wherein an increase in gram-negative bacteria (including Proteus) was noted in the small intestine of the adult rat following 650-R whole-body irradiation. Although Proteus is usually not pathogenic in the adult intestine, abdominal irradiation might have reduced the natural resistance of the bowel. (BBB)

6910 STUNTED GROWTH IN RATS FOLLOWING X IRRADIATION OF THE HEAD. Mosier, H. David Jr.; Jansons, Regina A. (Univ. of Illinois, Chicago). Growth, 31: 139-48(1967).

A study of conducted of physical growth in brain-irradiated rats to investigate the relation of dose of x rays to growth retardation, and the longitudinal growth pattern of the head-irradiated rat. The heads of 2-day-old Long–Evans rats were irradiated with doses of 250, 350, 400, 500, 600, 750, and 1000 R. The controls were sham-irradiated littermates. Mortality, general effects, body weight, and tail length were noted at weekly intervals up to 121 days, when the animals were sacrificed and measured for tibial length, fibial epiphyseal width, and organ weights. The effects of bovine growth hormone and thyroxine on body weight, tail length, tibial length, and tibial epiphyseal width were determined in irradiated stunted rats and controls. Body weight, tail length, and tibial length were reduced after 600-R irradiation. A dose of 350 R or greater caused significant reduction of body weight; 250 R produced no significant stunting. The pituitary gland underwent the greatest reduction in size relative to body weight at the 600-R dose level. The 750-R dose resulted in death of most of the animals, and 1000 R was lethal to all rats. Administration of growth hormone or thyroxine or both failed to correct the growth deficit of the stunted irradiated rats. Well-known endocrine mechanisms evidently are not responsible for the growth stunting. (BBB)

6911 EFFUSIVE-CONSTRICTIVE RADIATION PERICARDITIS: TWO CASES ILLUSTRATING VALUE OF ANGIOCARDIOGRAPHY IN DIAGNOSIS. Steinberg, Israel (New York Hospital, N. Y.). Amer. J. Cardiol., 19: 434-9(Mar. 1967).

In two women treated by mastectomy and irradiation therapy for cancer of the breast, effusive-constrictive pericarditis developed which was diagnosed 3 and 20 yr, respectively, following radiation therapy. Death, probably owing to cardiac tamponade and constrictive pericarditis, occurred in the first case; creation of a pericardial window with drainage of pericardial fluid into the left pleural space alleviated the symptoms of cardiac tamponade in the second patient. Dose in the first case was unknown, and in the second case 6000 R (type of radiation unspecified) had been given. In both cases, involvement of the lungs as well as the pericardium, was present in accord with the supposition that since the pericardium and heart are less sensitive to radiation than the lungs, the latter would also be damaged. Excision of both breasts in the second patient may have enhanced radiation penetration of the thorax and been an important factor for development of pulmonary fibrosis and pericarditis. Both patients were at first suspected of having heart disease, and pericardial effusive-constrictive disease was overlooked because the cardio-respiratory complaints were attributed to myocardial failure rather than to the pericarditis. (BBB)

6912 ADVANCES IN DIAGNOSIS AND TREATMENT OF POLYCYTHEMIA. Penington, D. G. Trans. Med. Soc. London, 82: 139-52(1966).

The hazard of leukemogenesis in patients with polycythemia vera treated with radiophosphorus was assessed. Some advantages of ^{32}P are that it is easily given by intravenous injection; the exact dose each patient received is known, which is not always the case with oral chemotherapeutic agents; and there are few side-effects. The main disadvantage of ^{32}P is that it may cause leukemia. There has been much confusion about leukemia occurring in polycythemia, but there is no doubt that acute leukemia when it occurs in polycythemia is much commoner in patients treated with ^{32}P. The incidence of acute leukemia in 4 published series of patients treated without any form of irradiation was one out of 233 deaths (0.4%). In patients treated with ^{32}P acute leukemia was responsible for between 8 to 30% of the deaths in 6 series. From these data there can be no doubt that the incidence of acute leukemia is greatly increased if the patients receive ^{32}P. Apart from the cause of death the survival of patients treated with and without ^{32}P appears to be the same, and although ^{32}P increases the risk of acute leukemia it prolongs life in polycythemia more effectively than any other treatment. It is likely that most persons would rather run some risk of dying of leukemia at an advanced age than dying younger without leukemia. (BBB)

6913 CARCINOMA OF THE BREAST. STAGE II: RADIATION RANGE. COMMENT: ARE METASTASES AND LYMPHEDEMA RADIATION-INDUCED. Rubin, Philip (Univ. of Rochester, N. Y.). J. Amer. Med. Ass., 200: 142-3(Apr. 10, 1967).

The advantages of radiation therapy as an adjunct to surgery in order to increase survival must not be offset by its complications. Numerous reports indicate that postoperative irradiation does more harm than good in that the increase in survival has not been regularly demonstrated and the radiation sequelae are progressive and debilitating. If evidence for a significant rate of serious radiation complications was established, the routine use of radiotherapy clearly should be abandoned. This evidence is examined. One report contends that postoperative irradiation increased the incidence of pulmonary and skin metastases. In many series, postoperative irradiation was associated with a higher incidence of lymphedema than surgery alone. Although irradiation per se rarely causes lymphedema, its contributory role cannot be denied by radiotherapists. The problems of pneumonitis and carditis caused by radiation are discussed. There has been a rise in detectable radiation pulmonary changes with the advent of supervoltage methods. The incidence has varied from 20% to 66%. The better and larger depth doses delivered to nodes are also delivered to underlying lung and heart. With the use of L-shaped anterior fields, the lung volume is so small that complaints are minor. With tangential breast fields, those patients receiving more than 5000 rad to the periphery of the lung may react with persistent cough and dyspnea on exertion. Although sporadic reports appear, claiming cardiac or coronary artery damage after irradiation, the results are mainly inferential, often lacking pathologic manifestation. The radiobiologic evidence indicates that only doses of 10,000 rad or more can produce myocardial damage. A controlled study on breast cancer patients who were serially studied with electrocardiograms for months to years showed only transient T wave inversions. The choice of using irradiation in breast cancer should be weighed in each patient and should depend on the stage of the disease and the type of surgery in regard to possible benefits and increase in survival rates. (BBB)

6914 BIOLOGICAL EFFECTS OF HEAVY PARTICLES. Atlan, H. Rev. Med. Aeronaut. (Paris), 5: 53-7(Apr.-June 1966). (In French).

Discussion of experimental results of investigations of the biological effects of heavy ions of primary cosmic rays. It is pointed out that quantitative studies have shown that the biological effects of heavy particles can be characterized by the following: a general high coefficient of RBE (relative biological efficiency) caused either by lethal or mutagenic effects attaining a peak and then diminishing in proportion to the increase in the LET (linear energy transfer), and an effect of direct type that is independent of partial oxygen pressure and is largely irreversible. (IAA)

6915 EFFECTS OF GAMMA RADIATION ON THE POST-EMBRYONIC STAGES OF A DERMESTID BEETLE, ANTHRENUS VORAX WATERHOUSE. Nair, K. S. S.; George, J. C. (M. S. Univ., Baroda, India). Entomol. Exp. Appl., 8: 241-8(1965).

Sensitivity of various postembryonic stages of A. vorax to ^{60}Co γ radiation at doses of 5, 10, 15, and 20 Krad was studied. Pupation was more or less completely inhibited; some larvae pupated after repeated molts or a reduction in size and regrowth. The pupae then emerged as normal adults. Percentage of successful molts decreased with increasing doses. At lower doses, more last-stage larvae died in the prepupal stage; at higher doses, larval mortality was higher. Irradiation of the early prepupa hampered the pupal molt; at the late prepupal stage, irradiation did not hamper the molt but produced certain malformations in the adult. In the pupal stage, the later the pupa was irradiated, the less susceptible it was to irradiation; irradiation during the first three days after pupation was more harmful than at a later time. Pre-emergent adults and pupae of five and six days were exposed to different doses of radiation. Data on the fecundity and fertility of various mating combinations of γ-irradiated and nonirradiated males and females are presented and discussed. (BBB)

6916 EFFECT OF RADIOPHOSPHORUS ^{32}P ON LIGHT RESPONSE OF AEDES AEGYPTI (L.) LARVAE. Strayer, John R. (Univ. of Florida, Gainesville). Fla. Entomol., 48: 81-4(June 1965).

To determine if varying levels of radiophosphorus have any effect on the light response of tagged A. aegypti larvae, four groups were placed in water, 0.1 μCi ^{32}P/ml, 5 μCi ^{32}P/ml, and 0.5N H_3PO_4 solutions. The results indicated that a concentration of radiophosphorus of 0.1 μCi/ml or greater decreased the light response of the larvae. Since the effect of phosphorus alone was considered as well as radiophosphorus, the radioactivity must have caused the variation in response and not the phosphorus. Since radioisotopes are being used commonly as labeling tools, it is important to realize that their use might alter behavioral patterns and lead to unreliable information. A behavioral change in the larvae of A. aegypti does not mean there would be a behavioral change in the adult, but it does open the area to further study. Tagging mosquitoes for the release-recapture method of population sampling requires that the adults merely be radioactive enough to be detected. This may allow use of concentrations of isotopes below the deleterious levels. Many tagging techniques require the use of very high concentrations of radioactive material. For this reason, the reactions of the specific insect to the chosen radioisotope should be thoroughly studied with relation to behavior and life history prior to any organized research use. (BBB)

6917 RADIOBIOLOGICAL FACTORS IN MANNED SPACE FLIGHT. Langham, Wright H. (ed.). Publication 1487. Washington, D. C., National Academy of Sciences–National Research Council, 1967. 288p. $7.50.

Data on human responses to radiation are reviewed and applied to evaluation of the potential radiation risks of manned space flights up to three years duration. Separate abstracts were prepared for eight of the nine chapters. Suggestions for additional research are also included. (M.M.B.)

For abstracts of individual chapters see: 6823, 6824, 6847, and 6918–6922.

6918 RADIOBIOLOGICAL FACTORS IN MANNED SPACE FLIGHT. pp 3-7 of Radiobiological Factors in Manned Space Flight. Langham, Wright H. (ed.). Washington, D. C., National Academy of Sciences–National Research Council, 1967.

The Space Radiation Study Panel of the National Research Council does not recommend permissible doses for manned space operations, but suggests that each space agency balance the potential risk of radiation injuries to astronauts against the anticipated gains of the missions and program. The Radiation Protection Guides provide a framework for radiation protection requirements. The

panel proposes to provide a quantitative description of the range of radiation risks assignable to different combinations of radiation exposure and to describe the upper limits of human tolerance to such exposure. Responses are evaluated in the following categories, which are listed in order of potential importance to missions up to two or three years duration: immediate or early sequelae (symptoms appearing within a few hrs or weeks following irradiation); progressive sequelae or semiacute hematopoietic deterioration during long flight periods; and probabilities of late or delayed sequelae necessitating intervention in planned flight series and astronaut careers. (M.M.B.)

6919 SPACE-RADIATION ENVIRONMENT. pp 8-26 of Radiobiological Factors in Manned Space Flight. Langham, Wright H. (ed.). Washington, D. C., National Academy of Sciences–National Research Council, 1967.

The types of radiation encountered interplanetary are described. Galactic radiation (often called cosmic radiation) consists of 85% hydrogen nuclei, 14% helium nuclei, 1% heavier nuclei up to iron, and so-called superheavy nuclei beyond iron. Dose rates from the galactic field outside the magnetosphere at solar minimum should not greatly exceed 50 m rads/day even with low shielding. Geomagnetically-trapped radiations consist of belts of protons and electrons that were forced into closed trajectories. The potential sources are protons and electrons from decaying cosmic ray neutrons backscattered from the Earth's atmosphere, protons from solar wind, primary cosmic-ray protons, and artificially injected electrons from atmospheric nuclear testing. The greatest radiation hazard in space is from solar-particle fluxes ejected from sun flares. Large flares are rare events occurring only a few times during the 4- to 6-year period of high activity in the 11-year solar cycle. They are accompanied by enhanced uv, x, and radiofrequency emission, disturbances in the geomagnetic field, and emission of protons, alpha particles, and heavier nuclei. Methods for estimating probable doses from these sources and for selecting favorable launch dates for manned missions of various durations are given. (M.M.B.)

6920 RADIATION EFFECTS IN MAN: EARLY EFFECTS. pp 59-133 of Radiobiological Factors in Manned Space Flight. Langham, Wright H. (ed.). Washington, D. C., National Academy of Sciences–National Research Council, 1967.

Early effects of radiation in man are discussed in relation to dose and dose rate. Emphasis is placed on performance of flight crews during the initial stages of the prodromal syndrome. The potential synergism of gravitation is identified as a significant variable in predicting both early and latent effects. It is pointed out that relation between radiation dose and lethality in healthy individuals is extrapolated from data on responses of seriously ill or moribund patients. A conservative estimate indicates that an average homogenous whole-body exposure of 10 to 12 rad/day or less will double the LD_{50} for man over that for a single acute exposure. (H.G.D.)

6921 RADIATION EFFECTS IN MAN: LATE OR DELAYED EFFECTS. pp 134-85 of Radiobiological Factors in Manned Space Flight. Langham, Wright H. (ed.). Washington, D. C., National Academy of Sciences–National Research Council, 1967.

Late or delayed manifestations of radiation damage are those that do not appear until after a period of months or years or that appear at any point in the life span of the individual. Included are: ocular lens changes, permanent skin damage, shortening of life span, leukemia and other neoplastic disease, and genetic changes. Latent injuries are qualitatively independent of radiation type and dose rate, though quantitatively dependent on site of exposure and total absorbed dose. The Space Radiation Study Panel estimated that ~20% of the crew members who receive lens doses of ~800 rads in an interval of a few weeks to about three months may develop clinically significant cataracts during their lifetime. Accumulated doses of 5,000 to 10,000 rems to the skin should be avoided regardless of protraction or fractionation in order to avoid permanent skin damage. It was arbitrarily determined that a life-shortening of 10 days/rad for radiations with a LET of 3.5 keV/μ and below should be assumed for space flight crews. Increase in mortality owing to leukemia exceeds the normal rate for leukemia by 1 and 4×10^6 exposed for 15 or 20 yr following exposure. Since astronauts are few in number, any deleterious radioinduced mutations in them would be negligible when diluted by the human gene pool. 152 references. (M.M.B.)

6922 OTHER FACTORS RELEVANT TO RADIOBIOLOGICAL ASPECTS OF MANNED SPACE FLIGHT. pp 186-239 of Radiobiological Factors in Manned Space Flight. Langham, Wright H. (ed.). Washington, D. C., National Academy of Sciences–National Research Council, 1967.

Learning capacity and retention are not altered in animals by head irradiation with acute exposures and doses as high as thousands of rads; morphological changes may, however, occur. Damage to other body systems with subsequent behavioral modification appears to be more limiting than exposure of the nervous system. The knowledge of radiation exposure may have profound psychological effects on the behavior of man. The effects of heavy cosmic-ray particles on manned space missions must be considered separately from the effects of other radiations. Observations using deuteron beams indicated that: enormous doses are required for brain cell destruction; lens cells are sensitive, but the number destroyed by a beam are too few to cause cataracts; and small doses will destroy pigments in hair. The possible interactions of radiation with noise, oxygen tension, temperature, physiological factors, emotion factors, vibrations, acceleration, and weightlessness are discussed. Owing to toxicity and limited effectiveness, chemical agents appear to offer less protection during manned space flights than would a slight increase in shielding. Many postirradiation treatments would be difficult under conditions of space flight. Accumulated radiation doses received by crews of the first 16 manned orbital flights were in the mrad range, and no radiation sequelae were observed. Thus, experience has thus far indicated negligible radiation risk during orbital flights near the Earth. 127 references. (M.M.B.)

Radiation Effects on Plants

Refer also to abstracts 6723, 6733, 6758, 6766, 6772, 6776, 6779, 6781–6785, 6787–6789, 6864, 6914, and 7966.

6923 (AD-648533) RADIOSENSITIVITY AND NUCLEAR VOLUME IN THE GYMNOSPERMS. Final Report, January 28, 1964–September 30, 1965. Cromroy, Harvey; Conger, Alan D. (Florida Univ., Gainesville). June 1966. Contract OCD-PS-64-69). 38p. CFSTI.

The sensitivities to acute ^{60}Co γ radiation of five species of gymnosperms were studied. The species were Pinus elliotti, Pinus palustris, Juniperus conferta, Podocarpus macrophylla, and Zamia floridana. The nuclear and interphase chromosome volumes (nuclear volume divided by chromosome number) were calculated from measurements of soot meristematic nuclei for each species. The plants, which were one to two year seedlings or one year old rooted cuttings, received acute radiation, taking care to shield the roots and thus simulate irradiation under natural growing conditions. The Gymnosperms are a very radiosensitive group of plants; the 50 percent lethal doses (LD_{50}) for the species studied ranged from 500 to 760R. The correlation between radiosensitivity and nuclear (or interphase chromosome) volume for the species studied agreed quite well with values obtained from other acutely irradiated woody species. For an untested species, determination of interphase chromosome volume will permit fairly accurate prediction of the LD_{50} dose to be expected. (TAB)

6924 (JPRS-43155) BIOLOGICAL EFFECT OF THE COMBINED ACTION OF GAMMA RAYS AND SPACE FLIGHT FACTORS ON BARLEY SEEDS. Nuzhdin, N. I.; Dozortseva, R. L. Translated from Zh. Obshch. Biol., 27: 397-42(1967). 20p. (TT-67-33780). CFSTI.

Irradiated (with 10 and 15 kR doses of ^{60}Co rays) and nonirradiated barley seeds in organic and forced dormancy were placed on Voskhod-1 for spaceflight. Similar seeds served as the control — some were flown to and from the spaceport by plane (control 1), while others were kept in Moscow (control 2). The effect of SFF was studied on seed germination and yield of cells with chromosome aberrations following exposure to gamma irradiation and without such exposure, with and without the use of a protector (cysteine). The SFF were found to accelerate the emergence of the seeds from organic dormancy, differing in this respect from γ irradiation. No increase in germination vigor or germination rate due to exposure to the SFF could be detected in the seeds that were in a state of forced dormancy. Cytological examination of cells of the primary rootlets of the experimental and control seeds showed that the SFF significantly increased the number of aberrant cells as compared with the control. This effect was noted only in the seeds in forced dormancy and in the seeds that spontaneously emerged from organic dormancy. The SFF did not induce any chromosome aberrations in the seeds in organic dormancy. This feature distinguished the effect of the SFF from that of ionizing radiation. Irradiation of seeds before and after spaceflight showed that gamma rays and SFF have an additive influence. As a result, in irradiated seeds in forced dormancy (or that spontaneously emerged from organic dormancy), the number of cells with aberrations in the experimental variations differed from the irradiated control by a value equal to the number of aberrant cells in the series without irradiation. A

comparison of the yield of aberrant cells per mrad of gamma radiation and one mrad of cosmic radiation (on the assumption that a genetic effect can be induced by cosmic radiation alone) showed that cosmic radiation is four to five times more efficient than gamma radiation. This disparity suggests that non-cosmic radiation is probably responsible for the genetic effect produced during spaceflight. The use of cysteine as a protector before the seeds germinate reduces the yield of aberrant cells. The modifying effect of cysteine was observed both in the previously irradiated seeds and in the seeds that were exposed to spaceflight conditions without irradiation. (auth)

6925 VARIABILITY OF QUANTITATIVE CHARACTERS IN MAIZE AS AFFECTED BY GAMMA IRRADIATION. Balint, A.; Sutka, J. (Univ. of Agricultural Sciences, Godollo, Hungary). Acta Agron. Acad. Sci. Hung., 15: 285-90(1966).

Air-dried kernels of the C5 maize line, inbred for several years, were treated with 5000 and 15,000 R of γ irradiation. In the M_1 generation anomalies of growth and development, so-called radiomorphoses, were observed. In the M_2 generation, variation of quantitative characters increased following irradiation, as compared with the nonirradiated population. Study of the relative distribution of frequency of the quantitative characters revealed that 5000 R increased the proportion of the positive variants more than 15,000 R. The wider variation range in the M_2 generation compared with the control also appeared in M_3. In M_3 the 15,000 R dose also increased the variation for some characters. It was concluded that for the induction of useful micromutations and for the widening of variation range in the quantitative traits, 5000-R exposure was more suitable than 15,000 R. Thus 5000 R was the better dose for balancing micromutations against the damage that occurred in the irradiated population. (BBB)

6926 FERTILIZATION ABILITY OF MAIZE POLLEN GRAINS. III. GAMMA IRRADIATION OF MATURE POLLEN. Pfahler, P. L. (Univ. of Florida, Gainesville). Contract AT(40-1)-3114. Genetics, 57: 523-30(Nov. 1967). (ORO-3114-4).

Mature pollen grains from the yellow (YY) single cross Wf9 × H55 were exposed to 0, 1, 2, 3, 4, and 5 kR of gamma irradiation. Mixtures were made containing equal volumes of pollen grains from each irradiation dosage and each of two white (γγ) single crosses, Ky49 × Ky27 (Ky) and K64 × K55(K). These plants were pollinated with mixtures containing Ky pollen and K plants were pollinated with those containing K pollen. The percent kernel set in relation to 0 kR and the percent lemon kernels (Yγγ) were determined on each ear. Highly significant negative correlations were obtained between irradiation dosage and both percent lemon kernels and percent kernel set, with highly significant positive correlations found between percent lemon kernels and percent kernal set. From these results, fertilization ability in terms of competition and participation in fertilization of the ovule does not appear to be altered by irradiation. The primary effect of irradiation is in reducing kernel development after fertilization is completed. When pollen was cultured on an artificial medium, the germination percentage or pollen tube length was not altered by irradiation, further suggesting that fertilization ability in terms of capacity to germinate and produce a pollen tube is not affected by irradiation. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 6786, 6844, 6864, 6906, 6909, and 6914.

6927 STUDIES OF INTESTINAL MICROFLORA. VI. EFFECT OF X IRRADIATION ON THE FECAL MICROFLORA OF THE RAT. Klainer, Albert S.; Gorbach, Sherwood; Weinstein, Louis (Tufts Univ., Boston). J. Bacteriol., 91: 378-82(Aug. 1967).

The effects of lethal, midlethal, and sublethal doses of whole-body x irradiation on the fecal microbial population of the rat was studied. No changes were observed in animals receiving sublethal doses of x radiation. Lethal and midlethal doses produced an increase in the numbers of fecal coliforms, fungi staphylococci, and streptococci; these changes were transient in rats that survived, but were more marked and persisted during life in those that died. The possible role of these alterations in intestinal microflora in post-irradiation infection and in death is discussed. (auth)

6928 THE INTERDEPENDENCE OF OXYGEN ENHANCEMENT RATIOS FOR 250kVp X RAYS AND FAST NEUTRONS. Alper, Tikvah; Moore, J. L. (Hammersmith Hospital, London). Brit. J. Radiol., 40: 843-8(Nov. 1967).

If m_n the oxygen enhancement ratio (O.E.R.) at high LET, is less than m_x, the O.E.R. at low LET, because of increased formation of oxygen within the target sites of the irradiated material, it follows that m_x and m_n must be interdependent, the ratio m_x/m_n, being linearly related to m_x. This relationship was tested by measuring m_n and m_x for six strains of bacteria with widely differing sensitivities to ultraviolet rays and therefore with values of m_x ranging from 1.8 to 3.5. The predicted relationship was observed, so the hypothesis is supported by this test, as well as by the independent evidence from measurements, made with a single strain, of the rate of increase of sensitivity with increasing oxygen concentration for neutrons and for x rays. On the other hand, the data do not fit predictions that follow from the hypothesis that O.E.R. is less at high than at low LET because of an increase in the proportion of interactions between neighboring radicals that replace interactions of isolated radicals with oxygen. The relationship between m_x/m_n and m_x must be general, if it is valid, and should therefore apply also to mammalian cells. This consideration could affect the selection of patients for neutron radiotherapy. (auth)

6929 LET AS A DETERMINANT OF BACTERIAL RADIOSENSITIVITY, AND ITS MODIFICATION BY ANOXIA AND GLYCEROL. Alper, Tikvah; Moore, J. L.; Bewley, D. K. (Hammersmith Hospital, London). Radiat. Res., 32: 277-93(1967).

Changes in radiosensitivity and in the radioprotection afforded by anoxia, glycerol, and other compounds were studied as a function of LET in Shigella flexneri Y6R. The radiations used were 5-MeV electrons, 250-kVp x rays, neutrons of mean energy 6 MeV, and beams of deutrons and helium nuclei in the range 60 to 800 MeV gm^{-1} cm^2. The bacteria were irradiated in suspension or on cellophane carriers. With the latter, an anomalously high value of oxygen enhancement ratio (o.e.r.) was observed for x rays, this value being higher also than for bacteria irradiated in suspension. Except for this, o.e.r. decreased with increasing LET. Protection ratios were the same for neutrons and radiations of low LET on suspensions, and, with the latter, the ratios were lower than when cellophane carriers were used. While the aerobic protection ratio was lower for helium ions at 800 MeV gm^{-1} cm^2 than for other radiations, there was little change up to 500 MeV gm^{-1} cm^2. Radiosensitivity in the presence of oxygen rose to a low maximum at about 200 MeV gm^{-1} cm^2. It is suggested that this increase in RBE may involve cellular biochemical interactions rather than primary damage alone. (auth)

Radiosterilization and Radiopreservation

Refer also to abstract 6334.

6930 (COO-1183-24) GROWTH CHARACTERISTICS OF TYPE E CLOSTRIDIUM BOTULINUM IN THE TEMPERATURE RANGE 34 TO 50 F. Progress Report, May 1-October 15, 1967. (Continental Can Co., Inc., Chicago, Ill. Metal Div. Research and Development). Contract AT(11-1)-1183. 14p. Dep. CFSTI.

SCHIZOMYCOTA— Clostridium botulinum, toxin production by, methods for assay of; Clostridium botulinum type C, isolation of pure cultures of, effects of sporulation on; Clostridium botulinum, types B and F, sporulation of, effects of culture medium on

MEATS— seafood, radiation processing of cod, in relation to dose, pH, spore load, temperature, and toxin production

SPORES— radiation effects on survival of Clostridium, in cod

6931 PASTEURIZATION OF FISHERY PRODUCTS WITH GAMMA RAYS FROM A ^{60}Co SOURCE. Ronsivalli, Louis J.; Slavin, J. W. (Technological Lab., Gloucester, Mass.). Commer. Fish. Rev., 27: 1-9(Oct. 1965).

A description is given of a research program on radiation-pasteurization of fresh fish so as to extend its shelf life. The results indicate that a number of economically important North Atlantic fishery products can be held refrigerated in an acceptable condition for at least one month after treatment with low doses of γ radiation without significant nutritive losses. The method is practical even when 50% of the shelf life has expired. An investigation of the chemistry of fish flavors and odors has not, thus far, revealed any evidence that irradiation causes the formation of aberrant or unusual compounds. Packaging studies showed that many commercially available plastic materials are suitable for packaging radiopasteurized fishery products, and that in most cases unsuitability was apparently due to high gas permeability rates and poor sealing characteristics. Total plate counts conducted before and after irradiation with 250,000 rad indicated that the bacterial flora in haddock fillets was reduced by ~99%. Microbiological and chemical assay techniques are described. (BBB)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

6932 (DP–1111) TABLES FOR DERIVING DIFFUSION COEFFICIENTS FROM CONCENTRATION GRADIENTS IN CYLINDRICAL RODS. Dexter, Arthur H.; Baxter, William V. (Du Pont de Nemours (E.I.) and Co., Aiken, S. C. Savannah River Lab.). Nov. 1967. Contract AT(07-2)-1. 16p. Dep. CFSTI.

For problems involving diffusion in cylindrical rods, computer-calculated tables are provided from which the experimentalist can readily calculate the diffusion coefficient from the measured concentration gradient in the rod. (auth)

6933 SPECIFICATION OF MATERIALS FOR USE IN NUCLEAR REACTORS. Hutcheon, J. M. (United Kingdom Atomic Energy Authority, Culcheth, Eng.). Powder Met., 10: 65-77 (Autumn 1967).

From Symposium on the Role of Powder Metallurgy in Nuclear Technology, London, Nov. 16–17, 1967. See CONF-671108.

Specific requirements in the selection of materials for use in nuclear reactors are discussed in relation to the basic facts of the fission reaction. Examples are given of the way in which these lead to: limitations on the permissible levels of elements of high thermal-neutron capture cross section; purity limitations arising from the need to restrict corrosion rates to an extent that will enable components to last a full reactor lifetime without replacement or maintenance; purity limitations imposed by the problem of the release of long-lived gamma-emitting nuclides to parts of the circuit outside the reactor shield; limitations on trace impurities significant to the radiation-damage process; particular requirements for crystal and pore structure related to radiation damage or in-pile corrosion phenomena; and special needs concerning material properties created by the existence of high heat fluxes in nuclear systems. (auth) (UK)

Corrosion and Erosion

Refer also to abstract 6985.

6934 (BAW–3765–4) CORROSION AND HYDRIDING OF ZIRCALOY. Quarterly Technical Progress Report No. 4, July 1 to September 30, 1967. (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Contracts AT(30-1)-3765; 59-3101. 32p. (EURAEC–1944). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

ZIRCALOY-4, ZIRCALOY-2 — corrosion by pure water under heat transfer conditions; hydriding in pure water under heat transfer conditions

ZIRCALOY-4 — mechanical properties of, effects of hydrogen and hydride distribution on

6935 BORON-BASE DIFFUSION COATINGS FOR NICKEL–CHROMIUM ALLOYS. Dombrobskaya, E. V.; Zemskov, G. V.; Kohan, R. L.; Shevchenko, I. M. Metalloved. Term. Obrab. Metal., No. 3, 39-42(1967). (In Russian).

Diffusion coating of ZHS6K Ni alloy (10% Cr, 5.8% Al, 2.9% Ti, 3.6% Mo, 4.6% W, 4.2% Co, and balance Ni) at 900°C in such powder mixtures as Bi–Al, Bi–Si, B–Ti, and B–Cr with 5% addition of NH_4Cl as activator is discussed. The diffusion coatings are oxidation tested at 1000°C in air and also corrosion tested at 900°C in seawater vapors and sulfurous exhaust fumes. The best oxidation and corrosion resistance is attained by coating in a B–Al powder mixture consisting of 30 to 40% B and 60 to 70% Al. In the case of other coatings, their high-temperature resistance is lower than in the case of simple boriding and their diffusion depth is unsatisfactory. To produce the diffusion coatings of Bi–Si, B–Ti, and B–Cr, it is recommended that coating be performed in two stages with the first step being boriding. (Rev. Met. Lit.)

6936 BEHAVIOR OF CARBON IN SYSTEMS OF THE METAL–MOLTEN LITHIUM–CARBON TYPE. Beskorovainyi, N. M.; Ivanov, V. K.; Zuev, M. T. pp 107-19 of High-Purity Metals and Alloys. Fabrication, Properties, and Testing. Emel'yanov, V. S.; Evstyukhin, A. I. New York, Consultants Bureau, 1967.

An attempt was made to estimate the behavior of C when various constructional materials are placed in contact with molten Li by studying the thermodynamic stabilities of the corresponding carbides represented by the change in free energy taking place when the carbides are formed. The ΔF^0_T curves, calculated for reactions in the solid phase without considering the solubility of C in the metals, give some idea of the processes taking place in the Me-Li_{liq}–C system. Use of the ^{14}C isotope provided a qualitative estimate of the relative disposition of the ΔF^0_T curves corresponding to carbide formation. Metallographic studies were carried out on the metal samples, and the results are reported. (B.L.M.)

Preparation and Fabrication

Refer also to abstracts 6297, 6520, 6521, 6559, 6996, 7016, and 7858.

6937 (IS–1703) GROWING NICKEL SINGLE CRYSTALS BY PULLING FROM A MELT. Herriott, James; Murtha, Marlyn; Burnet, George (Ames Lab., Iowa). Oct. 1967. Contract W-7405-eng-82. 15p. Dep. CFSTI.

The Czochralski crystal pulling technique was used to grow single crystals of nickel. Crystals ranging in size from 0.06 in. diam and 0.5 in. long to 1.5 in. diam and 9.0 in. long were grown using a NRC crystal pulling unit. Details regarding the procedure used are reported. (auth)

6938 (RFP–1032) PRODUCTION OF NEPTUNIUM METAL ON A 100 TO 400 GRAM SCALE. Baaso, D. L.; Conner, W. V.; Burton, D. A. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Dec. 5, 1967. Contract AT(29-1)-1106. 7p. Dep. CFSTI.

Procedures are described for the production of neptunium metal from neptunium oxide, and for the recovery of neptunium from reduction residues. Reduction yields ranged from 85.3 to 99.1%. High yields were obtained when 30% excess of calcium and 0.25 to 0.35 mole I_2 per mole of Np were used. Neptunium recovery was performed by nitric acid dissolution, anion exchange, and oxalate precipitation. (auth)

6939 TRY SHEAR SPINNING TO FORM TOUGH ALLOYS. Rose, Charles H. Tool Mfg. Eng., 59: 40-3(July 1967).

A missle nose tip of TZM Mo alloy (99% Mo and 1% Ti + Zr) requiring a hemispherical shape with a 13.7-in. nose radius for 160° blending in tangent to a 10° angle and a top-to-bottom wall thickness of 0.104 to 0.050 in. is difficult to machine. Forming methods considered are die forming, hydroforming, and shear spinning, with shear spinning being chosen because it is possible to control the required variable wall thickness, the mandrel and workpiece are easily heated with controlled gas flames, and only a male die is needed. The four machining stages for the nose tip are cutting the TZM plate to size, preforming by hand spinning, final forming by shear spinning, and trimming to length. Following trimming, the nose tip is polished to a finish suitable for plating and is inspected for cracks and conformance to drawing specifications. (Rev. Met. Lit.)

6940 ION EXCHANGE SEPARATION PROCESSES FOR NIOBIUM AND TANTALUM. Barney, Duane L.; Kent, Clifford E. (General Electric Co., Schenectady, N. Y.). Ind. Eng. Chem., Process Design Develop., 7: 1-5(Jan. 1968).

A flowsheet for production of niobium and tantalum oxides from columbite by ion exchange process was developed, based on data obtained in a literature search on niobium and tantalum ion exchange data and ion-exchange technology. Costs were estimated at $2.54 per pound of mixed oxides using fixed beds and $2.46 per pound using continuous contactors. Preliminary estimate of production by solvent extraction is $2.44 per pound. Optimistic assumptions were used in estimating ion-exchange costs, and a research and development effort would be necessary to prove the ion-exchange flowsheet and equipment. In contrast, solvent extraction is an established commercial process for producing niobium and tantalum. (auth)

6941 MELTING AND CASTING REFRACTORY OR REACTIVE METALS BY PLASMA ELECTRON BEAM. Kashu, Seiichiro; Hayashi, Chikara. Nippon Kinzoku Gakkaishi, 31: 413-19(Apr. 1967). (In Japanese).

A plasma electron beam generated from a Ta hollow cathode source was used to melt Ti, Zr, Mo, and Ta button ingots. The beam was operated under an Ar atmosphere between 1×10^{-3} and 5×10^{-1} torr. Assessment of the process is summarized. The furnace chamber should be evacuated to a high vacuum in the low 10^{-4} torr range before starting plasma generation. The purity of Ar used for the process definitely affects the quality of the buttons. Buttons obtained under Ar purified by using molecular sieve and liquid N_2 showed the same quality as ingots melted by using a high-voltage electron beam. Titanium alloys containing Al and

Mn were successfully melted with a smaller loss of the volatile component than the case of ordinary electron beam melting. The evaporation rate of Ti could be controlled by changing the pressure in the melting chamber. The plasma electron beam was more stable and easier to operate than the high-vacuum, high-voltage electron beam. (Rev. Met. Lit.)

6942 PILOT PLANT PRODUCTION OF NUCLEAR-GRADE ZIRCONIUM SPONGE FROM INDIAN ZIRCON. Subramanyam, R. B.; Sundaram, C. V. Trans. Indian Inst. Metals, 19: 9-20 (Mar. 1966).

Pilot plant production of nuclear-grade Zr sponge on 1 kg scale from Indian zircon is described. The flowsheet incorporates multiple recrystallization of potassium double fluorides for the removal of Hf and other impurities from Zr. The purified $KZrF_5$ is converted to ZrO_2, which is chlorinated to produce $ZrCl_4$ Magnesium reduction of the chloride followed by vacuum distillation gives Zr metal conforming to nuclear specifications. Operating conditions for optimum yields and purities in the various steps of the flowsheet are presented in detail. It was estimated that Zr metal is produced by the above process on a scale of 60 tons/year. (Rev. Met. Lit.)

6943 ELECTRON THEORY OF DIFFUSION WELDING. Samsonov, G. V.; Burykina, A. L.; Evityushenko, O. V. Automat. Weld. (USSR)(Engl. Transl.), 19: No. 10, 30-5(Oct. 1966).

The processes of electron exchange between atoms, occurring during diffusion welding of refractory metals, and metal-like and nonmetallic compounds, were examined. Optimum welding temperatures were established for the d-transition metals Ni, Ti, Nb, Mo, and W. Conditions for diffusion welding of titanium, molybdenum, and tungsten carbides from 1473 to 2273°K were developed. Diffusion welding temperature, time and rate are illustrated for the following materials: TiC–Mo, ZrC–Nb, ZrC–Ta, ZrC–Mo, ZrC–W, NbC–Nb, NbC–Ta, NbC–Mo, NbC–W, TaC–Nb, TaC–Ta, TaC–Mo, TaC–W, Mo_2C–Mo, MoC–W, WC–Mo, and WC–W. An experimental study of the feasibility of diffusion welding BCN to metals is reported. Attempts to join the boron carbonitride with Nb, Ta, Mo, and W, all the way up to melting temperatures, were unsuccessful. No traces of atomic interaction were determined. (Rev. Met. Lit.)

6944 EXPLOSIVE WELDING TODAY. Gandhi, S. C. Metalwork. Prod., 111: No. 17, 58-64(Apr. 26, 1967).

Many metals and alloys in various combinations have been welded explosively, including Al, Ni, Cu and their alloys, refractory metals, Au, Ag, and low-carbon and alloy steels. Incompatible metals can be joined with high weld strength and high strength; heat treatable alloys can be joined with no reduction in mechanical properties. There seems to be no limitation to the area of components which can be bonded. Welding mechanisms and the effects of variables (contact angle, stand-off distance, velocity of the upper plate, nature of explosive used, and mechanical and metallurgical properties of the metals to be joined) are given. Photomicrographs of weld interfaces are illustrated. Applications include cladding flat plates, cylindrical, spherical, and elliptical shapes, welding composite structures, and fabricating tubular transition joints between ferrous or Ni-base alloys and Zircaloy for nuclear reactor applications. (Rev. Met. Lit.)

6945 MANUFACTURE AND PROPERTIES OF MOLYBDENUM. Joly, F. Tech. Mod., No. 4, 167-72(Apr. 1966). (In French).

Molybdenum is described from the mining stage to its transformation into strips. The processes leading to the manufacture of the metal were analyzed in steps through the powder, sintered, and molten forms and a description is given of the two methods of smelting. (Rev. Met. Lit.)

6946 GALVANIZING OF SINTERED MATERIALS. Reinsch, Hans H. Sprechsaal Keram. Glas Email Silikate, 99: No. 24, 237-8(1966). (In German).

Sintered parts often require galvanizing to improve lubrication or joining properties. The necesary preparation for Ti, Zr, Th, U, Mo, W, Ta, and Be sintered parts involves mechanical polishing, degreasing, chemical leaching, electrolytic polishing, and surface activation. Specific treatments are listed for each of the metals. Finally, the methods of surface coating and posttreatment annealing are described. (Rev. Met. Lit.)

6947 PRODUCTION OF A TUNGSTEN JET PIPE NECK AT THE SEPR PLANT. Clar, G.; Reverdy, W. Tech. Mod., No. 5, 24-6(May 1965). (In French).

The hardness of W dictates certain precautions in machining this special shape. Slow turning, milling, and boring, at 3 rpm average speed, with carbide tools, cooled but not lubricated, achieve the desired results. Rotary template reproduction was used with careful mounting of the part to avoid breakage. (Rev. Met. Lit.)

6948 PLASMA TECHNOLOGY OF TUNGSTEN. Brunst, W. Schweissen Schneiden, 18: 239-40(May 1966). (In German).

The physical characteristics of gas plasmas are defin[illegible] as the fourth physical state which is reached when, due to high thermal agitation, a separation occurs between an atomic nucleus and electrons. The technical approach of reaching this state is given in the use of electrical arcs through which suitable gases are forced. This principle as applied in plasma burners is illustrated and its application to the depositing of W films discussed. An example is given for a W rod with 10 mm dia on which a 2 mm layer of W is deposited by plasma spraying. The difference in structure is illustrated by a macrosection. Another example is a nozzle that is fabricated by plasma spraying of W powder. For the process of deposit welding or plasma spraying of W a series of details are given such as current requirements and powder properties. W powders melt in the process of plasma spraying. The melted particles assume a spherical drop form. This phenomenon can be used by fabricating W parts of defined porosity. Another application of the plasma technology to the melting of W is the growing of W single crystals. (Rev. Met. Lit.)

6949 PRODUCTION OF HIGH PURITY Be BY ELECTROREFINING IN FUSED SALT BATHS. Bilard, J.; Boisde, G.; Broc, M.; Chauvin, G.; Coriou, H.; Hardy, J. (Centre d' Etudes Nucleaires, Saclay, Gif-sur-Yvette, France). Metaux (Corros.-Ind.), 42: 259-69(July-Aug. 1967). (In French).

The study of the electrorefining of Be on a pilot-plant scale was made in a $KCl–LiCl–BeCl_2$ bath fused at an average temperature of 475°C. The installation is such that the current production is 100 grams of Be per 24 hours for a charge of 25 kg of electrolyte. The possibility of obtaining a high purity metal was shown. The sum of the principal metallic impurities of commercial Be was lowered from a maximum of 4,000 ppM to 35 ppM after electrorefining. There is the possibility of contamination of the fused salts by the materials constituting the cell such as pyrex or silica. In effect the prolonged contact of the baths with these materials causes a contamination, principally in O_2 and Na. Ion exchange between the Li of the bath and the Na of the pyrex appears in the fused eutectic KCl–LiCl at 500°C. The presence of the phenomenon of concentration of the impurities in the immediate vicinity of the cathode was confirmed. It appears that the phenomenon is produced only for impurities more reducible than Be. (J.S.R.)

6950 THE ROLE OF POWDER METALLURGY IN NUCLEAR TECHNOLOGY. Symposium held in London, November 16–17, 1967. Powder Met., 10: 65-317(Autumn 1967). (CONF-671108).

Separate abstracts were prepared for 16 papers presented. (UK)

For abstracts of individual papers see: 6951–6955, 7014, 7015, 7023, 7027, 7031, 7049, 7050, and 7058–7060.

6951 UNITED STATES EXPERIENCE IN POWDER METALLURGY FOR NUCLEAR APPLICATIONS. Cunningham, G. W. (Atomic Energy Commission, Washington, D. C.). Powder Met., 10: 78-93(Autumn 1967).

From Symposium on the Role of Powder Metallurgy in Nuclear Technology, London, Nov. 16–17, 1967. See CONF-671108.

The types of problems encountered in the use of powder components for nuclear reactor cores are discussed. Examples are given of processes and experience related to the application of standard powder techniques to nuclear materials, use of novel methods for the production of nuclear materials, adaptation of commercial powder products for in-reactor use, and development of unique materials. (auth) (UK)

6952 PREPARATION OF ZIRCONIUM–COPPER AND ZIRCONIUM–COPPER–MOLYBDENUM ALLOYS BY SINTERING THE HYDRIDE POWDERS. Demars, H. (Societe Ugine Kuhlmann, Venthon, France); Meyer, R. Powder Met., 10: 145-55 (Autumn 1967).

From Symposium on the Role of Powder Metallurgy in Nuclear Technology, London, Nov. 16–17, 1967. See CONF-671108.

A method of recovering machining scrap from zirconium alloys by powder-metallurgy methods was studied. Observations made during the crushing and sintering of the hydride are described. The mechanical properties of the dense sintered parts are comparable with those of cast parts, apart from the hardening influence of the oxygen content. (auth) (UK)

6953 PRODUCTION OF TUNGSTEN ALLOY PENETRATION RADIATION SHIELDS. Jones, D. J. (General Electric Co., Ltd., Wembley, Eng.); Munnery, P. Powder Met., 10: 156-73(Autumn 1967).

From Symposium on the Role of Powder Metallurgy in Nuclear Technology, London, Nov. 16–17, 1967. See CONF-671108.

Manufacturing procedures are described for a series of high-density sintered W–Ni–Cu and W–Ni–Fe alloys covering a density range of ~17 g/cm³ to >18.5 g/cm³. Physical and mechanical property data for these alloys are given and the effect of sintering variables on these properties is discussed. Reference is made to equipment and techniques employed in the manufacture of radiation shields to meet the stringent demands of the increased strength of radiation sources and the widening scope for the application of radioactive elements. (auth) (UK)

6954 NOTE ON THE MANUFACTURE OF SAFETY AND CONTROL RODS. Eudier, M. (Societe Metafram, Beauchamp, France). Powder Met., 10: 216-20(Autumn 1967).

From Symposium on the Role of Powder Metallurgy in Nuclear Technology, London, Nov. 16–17, 1967. See CONF-671108.

Methods are outlined for the production of sheets, tubes, and flattened tubes. Stainless steel + boron, stainless steel + rare earths, and aluminium + boron carbide are employed as core materials, clad in stainless steel or aluminium. (UK)

6955 THE TECHNOLOGY OF UAl_3–Al IRRADIATION TEST PLATES. Thuemmler, F.; Nazare, S.; Ondracek, G. (Kernforschungszentrum, Karlsruhe, Ger.). Powder Met., 10: 264-87 (Autumn 1967).

From Symposium on the Role of Powder Metallurgy in Nuclear Technology, London, Nov. 16–17, 1967. See CONF-671108.

The literature concerning UAl_3 and UAl_3–Al dispersions is reviewed. Calculations of the strength of the dispersions were made. The experimental work described deals with the preparation of UAl_3 by induction melting, its chemical analysis, and crushing to the correct particle size for use in reactor fuel elements. The blending of UAl_3–Al dispersions and their compaction by cold pressing to densities suitable for roll-bonding are described, and their properties were determined. The picture-frame technique was used for the aluminum cladding of the UAl_3–Al dispersions, and to produce irradiation test plates. (auth) (UK)

6956 PROCEEDINGS OF THE CONFERENCE ON CHEMICAL VAPOR DEPOSITION OF REFRACTORY METALS, ALLOYS, AND COMPOUNDS, GATLINBURG, TENNESSEE, SEPTEMBER 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967. 469p. $12.50. (CONF-670905).

Separate abstracts were prepared for 26 of the 27 papers presented at the conference. The subjects covered include theory, methods, and application of chemical vapor deposition of refractory metals, alloys, and compounds. The remaining paper was previously abstracted for NSA and appeared as 21: 32904. (F.S.)

For abstracts of individual papers see: 6957–6969, 7007–7011, and 7039–7046.

6957 INTEGRATING FACTORS IN CHEMICAL VAPOR DEPOSITION. Blocher, J. M. (Battelle Memorial Inst., Columbus, Ohio). pp 3-17 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

Many refractory materials such as metals, metalloids, oxides, carbides, borides, nitrides, silicides, and sulfides can be prepared by chemical reaction of gaseous reactants. Examples range from pigment-grade TiO_2 produced by the oxidation of $TiCl_4$ in a flame reactor, through carbon coatings for nuclear-fuel particles, formed by thermal decomposition of hydrocarbons in a fluidized bed of the particles, to the vapor-forming of tungsten shapes by hydrogen reduction of tungsten hexafluoride. Many of the most promising applications are based on the unique morphological characteristics of the deposited materials. Because of the large number of variables involved, it has been necessary to treat the development of each process as a separate problem. An attempt was made to organize CVD technology qualitatively on the basis of the morphology-determining factors, supersaturation, temperature, and deposit-substrate interaction. (auth)

6958 MASS TRANSFER DURING CHEMICAL VAPOR DEPOSITION AT A CYLINDRICAL SURFACE. Carlton, Herbert E.; Oxley, Joseph H. (Battelle Memorial Inst., Columbus, Ohio). pp 19-33 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

A review is made of the diffusional processes that take place in the boundary layer that exists at a gas-solid interface. The solid is assumed to be of cylindrical shape and located with its axis perpendicular to a flowing stream of mixed gases which react and deposit a solid at the heated interface. This system is typical of many vapor-deposition systems of practical interest, and this review shows the essential considerations necessary to predict maximum deposition rates and to estimate local rates. (auth)

6959 DEVELOPMENTS IN ABLATION AND COMBUSTION APPLICABLE TO CHEMICAL VAPOR DEPOSITION. Gorton, C. W. (Georgia Inst. of Tech., Atlanta). pp 35-56 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

A general discussion is presented of developments in the theories of ablation, combustion, and reacting boundary layer flows and their applicability to chemical vapor deposition. The discussion of ablation and combustion is primarily concerned with the diffusional aspects, but includes consideration of surface phenomena in determining boundary conditions. It is pointed out that the basic difference between ablation, or combustion, and chemical vapor deposition is that in ablation or combustion, surface removal is taking place, while in chemical vapor deposition, mass is being added at the surface. Relationships developed in the fields of ablation and combustion are applied to the problem of chemical vapor deposition on an isothermal flat plate. The resulting solution for a laminar boundary layer with chemical equilibrium at the surface is presented. The well-known analogy between mass transfer and heat transfer is applied to the laminar boundary layer on an isothermal flat plate. Other applications of this analogy in the field of chemical vapor deposition are given. The modification of the boundary conditions required to incorporate nonequilibrium effects is also discussed. (auth)

6960 NUCLEATION AND GROWTH PROCESSES IN CVD. Gretz, R. D. (Battelle Memorial Inst., Columbus, Ohio); Hirth, J. P. pp 73-97 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

Nucleation and growth processes occurring in a gas phase and on or near a substrate in chemical vapor deposition (CVD) are enumerated. The theory of these processes is used to indicate the magnitude and direction of the rate-controlling reactions. At the substrate, supersaturation gradients, determined by temperatures and concentration, are shown to be important. Adsorbed molecule concentrations and temperature are related to specific coefficients of condensation and thermal accommodation. The spectrum of current theories of heterogeneous vapor-solid nucleation is considered from the viewpoint of possible influences on the morphology of CVD deposits. (auth)

6961 CHEMICAL VAPOR DEPOSITION STATISTICAL PARAMETRIC STUDY. Robinson, W. C. (Oak Ridge National Lab., Tenn.); Patterson, F. H.; Fleming, J. D.; Gorton, C. W. pp 109-25 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

Factors affecting the chemical vapor deposition of tungsten are being evaluated in a statistically designed parametric study. Eighty-one experiments were required in the WF_6–H_2 deposition system to provide a third-order polynomial correlation between the response parameters and the independent system parameters at 450 to 820°C, 9 to 20 torr, 60 to 370 cm³ WF_6/min, and 752 to 5240 cm³ H_2/min. The system parameters were H_2/WF_6 ratio, total flow rate, temperature, and pressure. The initial response parameters were determined for an internal deposit in a 15-in. length of a 0.807-in.-ID copper mandrel. The application and limitations of utilizing the resulting curves for systems of different size and geometry will be discussed. The deposition rate of tungsten at hydrogen fluoride mole fractions of 0.02, 0.05, 0.10, and 0.20 was also determined for each experiment and correlated with the system parameters. These data in conjunction with theoretical consideration of the system give indications of the rate-controlling process in portions of the experimental range. The agreement between theory and experiment and a preliminary interpretation of the deposition mechanism at various conditions are presented. (auth)

6962 CVD TUNGSTEN AND TUNGSTEN–RHENIUM ALLOYS FOR STRUCTURAL APPLICATIONS. PART I. PROCESS DEVELOPMENT. Holman, William R.; Huegel, Frank J. (Univ. of California, Livermore). pp 127-48 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals,

Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

Results of a continuing program to develop chemical vapor deposition (CVD) tungsten and tungsten-rhenium alloy structures with mechanical properties comparable to those of wrought products are presented. Equipment, techniques, and the effects of deposition variables are discussed. Short lengths of ½-in.-dia tubing were prepared by hydrogen reduction of the metal fluoride(s) on the outer surface of rotating, heated mandrels. New developments include: accurate control of the flow rate and WF_6/ReF_6 ratio by positive displacement metering of premixed liquid fluorides into a flash evaporator; and modification of the microstructure by mechanically rubbing the surface during the deposition process. Effects of temperature, pressure, gas composition (H_2/MF_6 and WF_6/ReF_6), gas velocity, mandrel rpm, and rubbing conditions are correlated with composition, macrostructure, microstructure, and deposition rate. Interpretations of microprobe data, replicas of the surface, and growth-ring effects are also included. Results are discussed in terms of deposition mechanisms and their probable effects on mechanical properties. (auth)

6963 EVALUATION OF METAL-ORGANIC COMPOUNDS AS MATERIALS FOR CHEMICAL VAPOR DEPOSITION. Papke, J. A.; Stevenson, R. D. (Ethyl Corp. Research Labs., Ferndale, Mich.). pp 193-204 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

An extensive study has been conducted on the feasibility of vapor plating pure refractory and other metals from metal-organic compounds. The experimental apparatus are described and the results discussed. The variables investigated were vapor generator temperature, carrier gas composition and flow rate, substrate temperature, and system pressure. Deposition of 10 single metals and 4 bimetals was studied, using 29 different metal-organic compounds. Compounds of metals from five groups (III-A, IV-B, V–B, VI–B, and VIII) in the periodic table were investigated. The purity and other metallurgical properties of the deposited metals were determined by electron and x-ray diffraction techniques. The metals plated in highest purity (90% or higher) were iridium, molybdenum, tungsten, and aluminum-tantalum. One of the outstanding advantages of vapor plating with metal-organics is the relatively low substrate temperature required to deposit the metal. For example, molybdenum was deposited at a substrate temperature of 350°C and aluminum at 250°C. Such low temperatures permit deposition of protective metals on parts that have been heat treated previously, without affecting the physical properties of the substrates. (auth)

6964 CHEMICAL VAPOR DEPOSITION OF BERYLLIUM METAL. Wood, J. M.; Frey, F. W. (Ethyl Corp., Baton Rouge, La.). pp 205-16 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

Beryllium metal coatings up to ten-mil thick were deposited on various substrates on a laboratory scale by thermal decomposition of di-tert-butylberyllium. The best coatings were gray in color, adherent, coherent, and oriented. At a thickness of one mil, the coatings were superficially smooth, but as thickness increased they became nodular. Chemical analysis of the deposits showed the purity of the beryllium to be 97+ wt %, the principal impurities being carbon and hydrogen. The best coatings were obtained by operating over a narrow range of temperature (280 to 305°C) and pressure (<1 torr). Various carrier gases were investigated and found generally to have a detrimental effect on coating quality. Other plating compounds were investigated, but were found to give less satisfactory results than did di-tert-butylberyllium. The effects of the various process parameters are discussed and the preferred conditions described. (auth)

6965 PREPARATION OF UNUSUAL REFRACTORY POWDERS BY FLAME PROCESSES. Merriman, J. R.; Smiley, S. H.; Kaufman, H. L. (Oak Ridge Gaseous Diffusion Plant, Tenn.). pp 229-41 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

Flame-reactor technology can serve as a bridge linking two important metallurgical sciences–chemical vapor deposition and powder metallurgy. By hydrogen reducing volatile refractory halide gases and mixtures in flames, it is possible to form metal and even prealloyed (on a single particle scale) powders with unique physical properties. Such powders can then be used in standard powder metallurgy operations to allow conventional preparation of a variety of homogeneous, high-performance parts and structures. Powders that have been produced to date by the hydrogen-fluorine chemical-flame process include tungsten, molybdenum, and technetium metal powders, as well as tungsten-molybdenum, tungsten-rhenium, tungsten-molybdenum-rhenium, and tungsten-technetium alloy powders. (auth)

6966 A REPORT ON THE CURRENT ROLE OF CHEMICAL VAPOR DEPOSITION AS A MANUFACTURING PROCESS. Glaski, Fred A. (San Fernando Labs., Pacoima, Calif.). pp 275-89 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

The hardware-oriented state-of-the-art of chemical vapor deposition (CVD) is summarized. Examples are presented whereby CVD processes were altered and controlled to refine the properties of the CVD material to meet specific application requirements; included are the production of fine-grained, equiaxial (rather than columnar) grain structures, grain oriented surfaces, and high-temperature, grain stabilized structures. Applications for CVD metals, alloys, insulators, composites, and dispersions are also discussed. Included are specific examples of products with hard coatings, corrosion-resistant coatings, and insulating coatings, and products that are not coatings but are free-standing and completely CVD fabricated. Established areas of application are noted ranging from advanced nuclear reactor, rocket, and electronic components to commercial products. (auth)

6967 ECONOMIC ANALYSIS OF FLUORINATION PROCESSES FOR THE RECOVERY AND RECYCLE OF VALUABLE CVD MATERIALS. Smiley, S. H.; Pashley, J. H. (Oak Ridge Gaseous Diffusion Plant, Tenn.). pp 291-302 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

High-purity metal fluoride feed stocks to be used directly for chemical vapor deposition of shapes and coatings or to prepare special refractory metal and alloy powders can be produced easily by a direct fluorination process. A detailed cost analysis of both the fluorination process and the flame reduction of metals fluorides to refractory alloy powders is given. The case presented shows a particularly attractive economic situation for the recovery of valuable scrap materials by this process. It is estimated that the cost for reconverting 400 lb/day of W–25% Re alloy from scrap to prealloyed powder via fluorination and flame reduction is only about $28/lb of contained rhenium, a small fraction of the current market value of this metal. (auth)

6968 APPLICATION OF CHEMICAL VAPOR DEPOSITION TO THE PRODUCTION OF TUNGSTEN TUBING. Martin, W. R.; Heestand, R. L.; McDonald, R. E.; Reimann, G. A. (Oak Ridge National Lab., Tenn.). pp 303-14 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

Chemical vapor deposition is used in the production of tungsten metal products as an aid in the fabrication of arc-cast, electron-beam-melted, and powder-metallurgy products and as a direct process for producing tubing. The direct process can be used to make tube shells for further working or tubing in its final form. The as-deposited structure of the chemical-vapor-deposited tungsten may be sufficient and/or desirable for some specific applications. Simple shapes such as tubing in lengths up to nearly 4 ft can be made easily and are less expensive than equivalent tubing made by the conventional extrusion-drawing method. Such tubes can be made in various diameters with wall-thickness variations not exceeding ±0.001 in. in the as-deposited condition. Therefore, this method is attractive for making shorter lengths of tubing of higher purity (less than 25 ppM total metallic impurities). If the as-deposited structure of chemical-vapor-deposited tungsten is undesirable, tube shells for further working can be made by chemical vapor deposition. These tube shells can be worked conventionally, as by extrusion and drawing. The microstructure of chemical-vapor-deposited material after working is comparable to that of arc-cast or powder-metallurgy products. If the amount of drawing is reduced to a few passes, the cost of worked chemical-vapor-

deposited tubing would be less than that of conventional tungsten tubing. (auth)

6969 GROWTH OF GRAIN BOUNDARY GAS BUBBLES IN CHEMICALLY VAPOR DEPOSITED TUNGSTEN. Farrell, K.; Houston, J. T.; Schaffhauser, A. C. (Oak Ridge National Lab., Tenn.). pp 363-90 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

Grain boundary gas bubbles that develop during annealing in tungsten deposited from WF_6 were studied as functions of annealing time and temperature and fluorine content. Measurements of the size and number of bubbles were obtained by quantitative electron fractography. In material containing 25 ppM fluorine, bubbles were found on the boundaries for annealing temperatures as low as 1450°C, but at these temperatures the distribution of the bubbles was highly heterogeneous. Size-frequency histograms were plotted for bubbles in specimens annealed at temperatures between 1600 and 2500°C. Bubble growth was slow at temperatures up to 2000°C, was significantly higher at 2200°C, and was rapid at 2500°C. Growth was shown to be consistent with a coarsening process causing swelling. It was demonstrated that at temperatures of 2000°C and below, coarsening of the grain boundary bubbles was solely at the expense of other bubbles on the grain boundary. At 2200°C, gas was attracted to the grain boundaries from within the grains. This happened early in the annealing treatment, but with increasing time further coarsening occurred by rearrangement of the gas in the grain boundary bubbles. At 2500°C, bubble growth was rapid and was assisted by an influx of gas from within the grains. The rate of growth decreased at 2500°C as the bubble size approached that for in situ interconnection. The gaseous species in the bubbles was not identified; however, the incidence of bubbles on the boundaries correlated well with fluorine content but was sensitive to the area of grain boundaries in the specimens. The total volume of bubbles was shown by density measurements to vary directly with fluorine content. (auth)

6970 HIGH-PURITY METALS AND ALLOYS. FABRICATION, PROPERTIES, AND TESTING. Emel'yanov, V. S.; Evstyukhin, A. I. New York, Consultants Bureau, 1967. 182p.

Translation of Metallurgiya i Metallovedenie Chistykh Metallov.

The book contains 26 articles. Questions of Nb refining and the structure of alloys giving corrosion-resistant films on Nb are discussed in several papers. A second group of papers deals with self-diffusion in pure U, the effects of purity on the behavior of U during annealing, and the compatibility of UC with W. Three papers deal with mechanisms underlying the interaction of molten Li with constructional materials. A third group of articles describes experimental systems developed for the extrusion of metals in liquid form under high pressure, a system for measuring hot hardness by static methods, equipment for floating-zone melting, and an adaptation for an x-ray camera. Abstracts were not prepared for any of the papers in the third group. Separate abstracts were prepared for 11 of the papers. (B.L.M.)

For abstracts of individual papers see: 6297, 6936, 6971, 6972, 6991–6995, 7064, and 7065.

6971 STUDY OF ALLOYS IN THE NIOBIUM–ZINC SYSTEM. Evstyukhin, A. I.; Godin, Yu. G.; Yakovleva, V. B. pp 37-43 of High-Purity Metals and Alloys. Fabrication, Properties, and Testing. Emel'yanov, V. S.; Evstyukhin, A. I. New York, Consultants Bureau, 1967.

The preparation of Nb–Zn alloys is described in detail, and the alloys were studied metallographically. A method for thermal analysis of the alloys is described; schematic representation of the x-ray diffraction photographs is presented; and the microhardness of the alloys is tabulated. The existence of 4 previously reported intermetallic compounds, $NbZn_3$, $NbZn_2$, Nb_2Zn_3, and NbZn was confirmed. Study of phase transformations in Nb–Zn alloys at temperatures above 1000°C was found to require special equipment so that the work could be carried out at high pressures. (B.L.M.)

6972 CRYSTALLIZATION FRONT IN ELECTRIC-ARC ZONE MELTING. Milov, I. V.; Skorov, D. M.; Nikishanov, V. V. pp 45-9 of High-Purity Metals and Alloys. Fabrication, Properties, and Testing. Emel'yanov, V. S.; Evstyukhin, A. I. New York, Consultants Bureau, 1967.

The crystallization front in electric-arc zone melting is of complicated form and is influenced by impurities in the sample. An equation is given for determining the impurity-transfer velocity associated with the motion in the molten zone. The apparatus used for the electric-arc zone melting studies is described, and autoradiograms that show the shape of the crystallization front during melting are reproduced. Crystallization pulses were also studied by the autoradiography. (B.L.M.)

6973 IMPROVEMENT IN THE CASTING OF ALUMINUM–URANIUM ALLOY. Takahashi, Seiji (to Sumitomo Metal Ind., Ltd.). Japanese Patent 1966-12723. July 19, 1966. Filed Oct. 5, 1963.

When a fuel element of Al–U alloy is prepared, the alloy is first cast in an ingot of 20 ~ 30 mm thickness, it is then rolled flat into a thickness of several mm, and finally cladded on both sides with aluminum plate. If the U content in the alloy is 14 ~ 50 wt %, the cast ingot has Al–U compounds of large grain sizes in it. The resulting disadvantages are the unfavorable processing after casting, including extrusion cracking; and un-uniform uranium distribution in the final product due to difficulty in crushing the large-size grains. The method described eliminates these drawbacks. In casting Al–U alloy of U content 14 ~ 50 wt % into an ingot, the mold, heated at 150 to 350°C, is vibrated with an amplitude of 0.1 ~ 0.4 mm, in order to minimize the grain size of the Al–U compounds and to uniformly distribute different grain sizes in the material. (NSA of Japan)

6974 BERYLLIUM–ALUMINUM ALLOYS AND METHOD OF PREPARING SAME. (to Lockheed Aircraft Corp.). British Patent 1,094,269. Dec. 6, 1967. Priority date Dec. 6, 1963, United States.

A powder metallurgical method for producing Al-base–Be alloys with improved properties of strength, ductility and fabricability is described. The alloy is at least 50% by weight Be, the rest is Al, in the form of a beryllium-rich phase and an aluminum-rich phase. The beryllium-rich phase is in the form of an irregularly shaped network interspersed with the aluminum-rich phase. The alloy is prepared from a starting material in the form of fine Al coated Be powder or small particles of Al–Be alloy. The material is compacted and pressed into the desired form and annealed at a temperature below 1193 and above 1150°F. (F.S.)

6975 METHOD FOR PRODUCING GRAPHITE–THORIUM CARBIDE FUEL ELEMENTS FOR A HIGH-TEMPERATURE THERMAL BREEDER REACTOR. Oikawa, Takashi (to Showa Dendo K.K.). Japanese Patent 1966-12719. July 19, 1966. Filed May 24, 1963.

A method of producing a fuel element of graphite-thorium carbide suitable for use in a high-temperature, thermal breeder reactor, is described. A binder, comprised principally of furfuryl alcohol, is added to the powders of high purity natural graphite and metallic thorium, and the whole is homogeneously mixed. The mixture is then molded into the form of a fuel element at temperatures of about 110°C. The molded material is sintered in two stages for the final product, first up to 600°C and second up to 2100°C. (NSA of Japan)

6976 IMPROVEMENTS IN AND RELATING TO TUNGSTEN-BASE ALLOYS. (to Mallory Metallurgical Products Ltd.). British Patent 1,090,561. Nov. 8, 1967. Priority date Jan. 27, 1964, United States.

A method for producing a tungsten-base alloy with improved strength, ductility, and density is described. The alloy consists of up to 0.5% Ru, up to 6% Ni, up to 1.5% Fe, and up to 2% Mo, the balance, apart from impurities being at least 90% W. A saturated solution of ruthenium trichloride in water is prepared. Tungsten powder is added while stirring and heating to reduce the ruthenium to metal. Ni, Fe, and Mo powders are added in the required proportion. The mixture of powders is compacted and sintered. (F.S.)

6977 METHOD FOR PRODUCING HIGH DENSITY TUNGSTEN INGOTS. Zima, Gordon E.; Lakner, John A. (to U. S. Atomic Energy Commission). U. S. Patent 3,356,495. Dec. 5, 1967.

A process is described for producing W ingots of high structural integrities and of above 98% theoretical density by compacting W powder at temperatures above 900°C and at pressures up to about 50 kilobars, and then decompressing the powder before the temperature is lowered below about 700°C. (AEC)

6978 METHOD OF BONDING OBJECTS OF DISSIMILAR METALLIC COMPOSITION. (to Atomic Energy of Canada Ltd.). British Patent 1,092,244. Nov. 22, 1967. Priority date Sept. 11, 1964, United States.

A method is described for bonding two metallic objects of dissimilar composition and strength. The articles are arranged in juxtaposition to each other with the surface of the second to be bonded in spaced confronting relation with respect to the bonding surface of the first. A source of energy is placed adjacent to the

second article having the lower strength, and energy is released at an explosive rate from the source to impinge the metal of the surface of the second object against the transition layer on the other of the surface, and thus to bond the surface and layer together. The transition layer is an oxide of the metal of the first object and is thick enough to prevent penetration by the metal of the second object but not thick enough to be brittle. The method is suitable for bonding objects of stainless steel and aluminum, for bonding Zr alloys and aluminum, and for bonding stainless steel and Zr alloys. (B.L.M.)

6979 ZIRCONIUM ALLOY ARTICLE. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 1,091,154. Nov. 15, 1967. Priority date Apr. 11, 1964, Germany.

A Zr alloy is described that may take the form of a shaped rod, plate, or tube for use in a nuclear reactor. The article comprises a first metal part made of a high-strength Zr alloy and a second metal part made of a corrosion-resistant Zr alloy adjacent to the first part and arranged to protect an area of the first part from corrosion. The article may include a layer between the first and second parts, which is impervious to or can inhibit the diffusion of a gas from one part to the other. The layer is made of a material which is resistant to radiation and which has a low neutron cross section. (B.L.M.)

Properties Evaluations

Refer also to abstracts 6548, 6944, 6945, 6952, 6970, 6971, 7023, and 7059.

6980 (BARC-295) EFFECT OF THERMAL TREATMENT ON HARDNESS AND TENSILE PROPERTIES OF Zr-0.5 WT PERCENT Nb-1.0 WT PERCENT Cr ALLOY. Ray, S.; Mukherjee, J. L.; Mehta, M. L. (Bhabha Atomic Research Centre, Bombay (India)). 1967. 20p. Dep.

The hardening of Zr-0.5 wt % Nb-1.0 wt % Cr alloy by thermal treatment was examined. Samples were water quenched from 850, 900, and 950°C and tempered between 400 and 700°C. Martensitic transformation takes place in as-quenched alloy and is associated with substantial hardening. The 0.2% yield stress and ultimate tensile stress of the annealed samples are 40,000 and 56,000 psi, respectively, whereas those for samples water quenched from 900°C are 105,400 and 135,900 psi. The hardness and strength fall on tempering and an appreciable drop in strength is observed on tempering above 500°C. Examination of structural changes by optical and transmission electron microscopy reveals that solute hardening is a dominant factor to the high hardness of as-quenched martensite. The hardening decreases on tempering due to precipitation of $ZrCr_2$. (auth)

6981 (EURAEC-1927) STUDY OF WELDED JOINTS ON VERY THICK STEEL PLATES. Special Report No. 2. Granjon; Videau; Gaillard (Institut de Soudure, Paris (France)). Sept. 15, 1967. Contract 007-64-TEEF(RD). 48p. (EUR-3754). Dep. CFSTI.

Work Performed under United States-Euratom Joint Research and Development Program.

The cooling behavior of two steels under the effect of welding thermal cycles was studied by in situ thermal analysis. Charpy Vimpact tests were also carried out. It was concluded that in the stress-relieved melted metal of a multi-pass weld, several families of specimens should be taken. The position of the notch in relation to the successive passes did not seem to have appreciable influence on the results. The weld zone showed great homogeneity to the impact strength test as regards the influence of specimen sampling direction. (M.C.G.)

6982 (IS-T-131) THE EFFECT OF OXYGEN ON THE MECHANICAL PROPERTIES OF THE Nb-1 PERCENT Zr ALLOY. Foune, Charles Clifford (Ames Lab., Iowa). Nov. 1966. Contract W-7405-eng-82. 104p. Dep. CFSTI.

Thesis.

In the presence of liquid metal coolants containing up to 2000 ppM of oxygen, Nb-1% Zr alloy becomes contaminated with oxygen, especially at temperatures above 1000°C. When this alloy is contaminated with oxygen, the oxygen occurs in the form of a ZrO_2 dispersion. Data are tabulated to show the effects of such oxide dispersions on various tensile properties as functions of temperature and oxygen content. (D.E.B.)

6983 (RFP-1051) LITERATURE SURVEY: PHYSICAL PROPERTIES OF LITHIUM AND BERYLLIUM AT LOW TEMPERATURES. Lott, Layman A. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Dec. 6, 1967. Contract AT(29-1)-1106. 6p. Dep. CFSTI.

A literature search was made of physical properties of lithium and beryllium in the cryogenic temperature range from 0 to 130°K (-273 to -143°C). Information on such properties as thermal expansion, phase transformations, and mechanical strength of these materials is summarized. (auth)

6984 (CONF-640310-1) SUPERCONDUCTIVITY OF FUSED SAMPLES OF THE SYSTEMS Nb-Sn, Nb-Al, Nb-Ga, V-Si, AND V-Ga. Kunz, W.; Saur, E. Translated by T. O. Lazarides (Atomic Energy Research Establishment, Harwell, Eng.), from Z. Phys., 189: 401-16(1966). 33p. (CONF-651-92). Dep. CFSTI. UK. JCL $3.60 fs, $1.19 mf.

From Meeting of the Low Temperatures Specialist Committee, Karlsruhe, Ger. and 9th International Conference on Low Physics, Columbus, Ohio, Aug.-Sept. 1964.

Samples of Nb-Sn, Nb-Al, Nb-Ga, V-Si; V-Ga, and Nb_3Sn with partial replacement of Nb by Ti, Zr, V, and Ta were melted in an arc furnace. The transition temperatures and the transition breadths of these samples in the untempered and the tempered states were measured by inductive and resistive methods. A correlation of the binary samples and of their superconductive properties with the known phase diagrams of the corresponding systems was undertaken by means of structural investigations. (auth)

6985 (JPRS-43171) NIOBIUM-BASED ALLOYS AND THEIR PROPERTIES. Savitskii, E. M.; Baron, V. V.; Ivanova, K. N. Translated from At. Energ. (USSR), 23: 32-7(1967). 13p. (TT-67-33796). CFSTI.

Multicomponent refractory alloys based on niobium were developed. Mechanical properties, long-term strength, corrosion resistance to lithium, recrystallization temperatures, and annealing of Nb-W, Nb-W-Zr, Nb-W-Mo-Ti, Nb-W-Mo-Zr, and Nb-W-Ti alloys were studied. (M.C.G.)

6986 EFFECTS OF IRON AND MOLYBDENUM ON THE HIGH-TEMPERATURE PROPERTIES OF CHROMIUM BASE ALLOYS. Yoda, Renpei; Yoshida, Heitaro. Nippon Kinzoku Gakkaishi, 31: 501-6(Apr. 1967). (In Japanese).

To obtain Cr-base alloys with excellent creep strength and hot workability, about 20 alloys containing 15 to 30% Fe and 5 to 25% Mo were prepared by vacuum melting. The composition range in which hot working is possible by swaging was determined, and effects of Fe and Mo on the high-temperature properties, deformation resistance, age hardening and bending creep properties, etc., were examined. The effect of cleanliness of the alloys on the age-hardening properties, and effect of harmful elements on the hot working characteristics were investigated. Age-hardening properties depend on the precipitation of the σ phase, which is determined by the alloy composition and its property is retarded by raising the alloy's cleanliness. Nitrogen affects most seriously high-temperature ductility. Oxidation resistance deteriorated considerably in the alloy containing more than 20% Mo in the test condition of 100 hr heating at 1000°C in air. Deformation resistance at 1100 and 1200°C increased with increasing Mo content when the Cr content was constant, or with increasing Cr content when the Mo content was nearly constant. The composition range in which hot working is possible by swaging depends on the phase behavior, deformation resistance, and the brittleness, which are determined by the alloy's composition. Creep property tends to be improved by raising the alloy's cleanliness and by increasing the Mo content when the Cr content is constant and by increasing the Cr content when the Mo content is constant. The creep property of the worked alloy is superior to that of cast alloy having the same composition, considered to be due partly to the spheroidization of chromium oxide. (Rev. Met. Lit.)

6987 INFLUENCES OF THE ADDITIONAL ELEMENTS ON SOME PROPERTIES OF HIGH-ZIRCONIUM Cu-Zr ALLOYS. Suzuki, Hisashi; Kawakatsu, Ichiro; Kitano, Hitoshi; Murase, Akeji. Nippon Kinzoku Gakkaishi, 31: 14-19(1967). (In Japanese).

Effects of additional elements on the properties of Cu 1.3%-Zr alloy were studied, aiming at improvement of their properties. Each element such as Be, Ti, Cr, Fe, Ni, Co, misch metal, Al, Si, As, Ag, Cd, Sb, and Te was added at a rate of ≈0.5% to the straight alloy. Specimens were cast, hot worked at about 850°C, solution-annealed at 880 to 890°C for 40 min, quenched, and finally cold rolled by about 83% to become 0.5 mm thickness sheets. Properties of the specimens in various aged states were examined. Hardness increased with increasing additional elements, except the addition of misch metal and Sb, which caused a decrease in hardness. Tensile strength was generally improved with increasing additional elements, particularly by the addition of Ti, Cr, Co, and a very small amount of Si. Elongation at half-softening-temperature decreased generally with the additions. Electric conductivity decreased slightly with increasing additional elements except Ti, Fe, and Al. Softening resistance and high-temperature hardness were improved by the addition of Cr, Co, Si, and As. Oxidation resistance was also improved by the additional elements, except

Te. It was found that the Cu–Zr–Cr, Cu–Zr–Co, and Cu–Zr–Si alloys were superior to the others as well as to the binary alloy, as high-strength, conductivity and heat resistance materials. (Rev. Met. Lit.)

6988 ABNORMAL PHENOMENA AT STRESS RELAXATION IN BERYLLIUM BRONZE. Grachev, S. V.; Zubov, V. Ya. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met., No. 2, 121-3(1967). (In Russian).

In producing elastic elements, such as springs, from beryllium bronze, an abnormal occurrence of the processes of direct and reverse anelastic creep is observed. Stress relaxation during bending of a thin strip of the alloy is frequently accompanied by a stress drop to zero, with subsequent redistribution and growth of stress with a reverse sign. Stress relaxation in the bronze at 300°C, after quenching and tempering at various temperatures (to 500°C), was determined. Straight and reverse anelastic creep was plotted for the bronze at 200°C after quenching, at 300°C after quenching and aging at 100°C, 1 hr, and at 300°C after quenching and aging at 450°C, 1 hr. Straight anelastic creep of strip specimens was conducted in rings, reverse anelastic creep by heating the specimens in free state. Longest time of both straight and reverse anelastic creep was 10 hr. (Rev. Met. Lit.)

6989 AGE EMBRITTLEMENT OF MULTIPASS WELDED SUPERALLOY JOINTS. Ireland, D. R. Weld. J. (N.Y.), 46: 270s-82s(June 1967).

The results of an investigation of the effects of prolonged exposures (in an inert atmosphere) at 1000 to 1600°F on the precipitation hardening of multipass welded Hastelloy X and Hastelloy W filler metals in dissimilar superalloy joints are described. Weld joint specimens of Hastelloy X-280 plate to L605 plate and Hastelloy X-280 plate to Type 316 SS plate were joined by the gas W arc welding process. The weld joint specimens were aged at 1000, 1200, 1400, and 1600°F for periods of 500, 1000, and 5000 hr. Both of the weld metals are solution-strengthened Ni-base superalloys, and exposure at 1000 to 1600°F results in precipitation hardening. Investigation was primarily concerned with the effects of this hardening or age embrittlement on the ductilities of the two Ni-base weld metals. The effects of similar aging treatment on the mechanical behaviors of the superalloy base metals, Hastelloy X-280 and L605, were also investigated. The relative age embrittlements of these materials were evaluated from bend tests, tensile tests, hardness tests, and metallographic examinations. Both weld metals reach a similar minimum ductility of 3% for both the room temperature and elevated temperature tensile tests. The most severe age embrittling temperatures for these two weld metals are 1400°F for Hastelloy W and 1200°F for Hastelloy X. (Rev. Met. Lit.)

6990 SOME PROPERTIES OF COPPER HIGH-ZIRCONIUM, HIGH-CHROMIUM ALLOYS. Suzuki, Hisashi; Kawakatsu, Ichiro; Kitano, Hitoshi. Nippon Kinzoku Gakkaishi, 31: 342-6(Apr. 1967). (In Japanese).

Studies were made on the properties of Cu alloys containing 0.73 to 1.46% Zr and 0.77 to 1.93% Cr. Results show that the temperatures of 950 and 450°C were best suited for solution-treatment and aging of Cu–Zr–Cr alloys, respectively. Mechanical properties, such as hardness and tensile strength, were superior to Cu–Zr and Cu–Cr alloys. The reason may be the increased solid solubility in Cu–Zr–Cr alloys. Electric conductivity of the alloys was somewhat lower than others; however, it was found that conductivity increased remarkably on prolonged aging, affecting almost no reduction in strength. The sequence of precipitation in Cu–Zr–Cr alloys appeared to be a combination of Cu–Zr and Cu–Cr alloys. Heat resistivity and electric conductivity of the alloys could be explained in relation to those of Cu–Zr and Cu–Cr alloys. The characteristic properties of Cu–Zr–Cr alloys that are more than 60 kg/mm^2 in strength and more than 80% in conductivity were easily obtained. (Rev. Met. Lit.)

6991 EXPERIMENTAL STUDY OF THE EFFECT OF TEMPERATURE GRADIENT ON THE DISTRIBUTION OF HYDROGEN IN ZIRCONIUM. Emel'yanov, V. S.; Borkov, N. V.; Evstyukhin, A. I.; Kazakevich, A. T. pp 7-13 of High-Purity Metals and Alloys. Fabrication, Properties, and Testing. Emel'yanov, V. S.; Evstyukhin, A. I. New York, Consultants Bureau, 1967.

An apparatus for obtaining longitudinal and radial temperature gradients in cylindrical samples of Zr is described. The influence of such temperature gradients on the migration of H_2 in Zr was determined, and it was found that H_2 migrates from heated to cooled zones with the maximum H_2 concentration occurring when the temperature lies between 245 and 260°C. Curves representing the change in H_2 concentration due to the temperature gradients as a function of position are presented. The microstructure of the samples was determined both before and after H_2 migration, and chemical analysis of lathe chips was also used to determine H_2 migration. (B.L.M.)

6992 DIFFUSION OF YTTRIUM IN ZIRCONIUM. Fedorov, G. B.; Zhomov, F. I.; Smirnov, E. A. pp 15-16 of High-Purity Metals and Alloys. Fabrication, Properties, and Testing. Emel'yanov, V. S.; Evstyukhin, A. I. New York, Consultants Bureau, 1967.

The diffusion of Y in both α- and β-phase Zr was determined for samples of iodide Zr remelted in an arc furnace using ^{90}Y. The isotope was deposited on the samples by vacuum evaporation, and the samples were joined together in pairs with the radioactive surfaces facing one another and wrapped in Mo foil. Diffusion annealing of the β-Zr was carried out at 1100, 1200, 1260, and 1335°C; diffusion in the α phase was studied at 800°C. Annealing periods were 21, 84, 27, 26, and 60 hr at the various temperatures. The diffusion was studied by the layer-removal method. The amount of diffusing Y in any diffusion zone lay within the solubility limit for the temperature in question. The calculated diffusion coefficients were tabulated, and were very close to the self-diffusion characteristics for Zr. (B.L.M.)

6993 PROPERTIES OF IODIDE-TYPE HAFNIUM AND ALLOYS IN THE ZIRCONIUM–HAFNIUM SYSTEM. Evstyukhin, A. I.; Barinov, I. P.; Korobkov, I. I. pp 23-30 of High-Purity Metals and Alloys. Fabrication, Properties, and Testing. Emel'yanov, V. S.; Evstyukhin, A. I. New York, Consultants Bureau, 1967.

The iodide method was used to prepare very pure Hf and Hf–Zr alloys. Hardness and microhardness of the iodide-type Hf were determined in various states and are tabulated. The effects of O and other impurities on these properties were examined. The composition and impurity content of Hf–Zr alloys prepared by the iodide method are shown in tables, and the liquidus line for the system was determined experimentally. The variation in the density and hardness of the Hf–Zr alloys was determined in terms of composition. Kinetics of the oxidation of the alloys were determined in both air and O_2 at 800°C using iodide samples and other samples remelted from the pure iodide-type metals. (B.L.M.)

6994 EFFECT OF OXYGEN IMPURITY ON THE STRUCTURE AND SUPERCONDUCTING PROPERTIES OF ZIRCONIUM–NIOBIUM ALLOYS. Bychkov, Yu. F.; Goncharov, I. N.; Khukhareva, I. S. pp 31-5 of High-Purity Metals and Alloys. Fabrication, Properties, and Testing. Emel'yanov, V. S.; Evstyukhin, A. I. New York, Consultants Bureau, 1967.

The effects of O impurities on critical current density J_c, decomposition of the β solid solution for Zr–Nb alloy system, and the Zr–Nb phase diagram were investigated. The effects of intermediate annealing on J_c were also studied. The introduction of small traces of O into the Zr-base alloys enabled the value of J_c to be considerably raised, especially if intermediate annealing followed by cold-rolling was employed. An explanation for this rise in J_c is given. The O impurities led to a rise in the hardness of the alloys and caused the separation of the β solid solution into two solid solutions of different concentrations. (B.L.M.)

6995 VARIATION OF HARDNESS DURING THE ISOCHRONAL AND ISOTHERMAL ANNEALING OF WORKED URANIUM WITH VARIOUS DEGREES OF PURITY. Tsvetaev, A. A.; Chuzhko, R. K.; Bovenko, V. N.; Golovanov, Yu. N. pp 85-9 of High-Purity Metals and Alloys. Fabrication, Properties, and Testing. Emel'yanov, V. S.; Evstyukhin, A. I. New York, Consultants Bureau, 1967.

Recovery of hardness in the isochronal annealing of U of various degrees of purity after working and the activation energy of the stress-relaxation process were studied. The higher the impurity content, the higher was the temperature corresponding to the maximum hardness. The maximum noted on the isochronal hardness-recovery curve was found to be due to strain-aging processes. The recovery of hardness at T > 300°C was found to be due to processes of self-diffusion in the presence of internal stresses. The activation energy of self-diffusion for α U was determined as U_s = 4500 cal/mole. (B.L.M.)

6996 LANTHANUM GERMANIDES. Lyutaya, M. D.; Goncharuk, A. B. Sov. Powder Met. Metal Ceram. (Engl. Transl.), No. 6, 479-82(June 1966).

The conditions for obtaining lanthanum germanides $LaGe_2$, LaGe, and La_5Ge_3 by synthesis from elements in an arc furnace and lanthanum digermanide by a thermal method were investigated. Some chemical properties of lanthanum germanides were studied: stability of germanide powders in water and thermal stability in air and in an ammonia medium. Oxidation of germanides passes through lanthanum oxygermanide formation. During interaction of lanthanum monogermanide with ammonia, LaGeN was formed as a product. (Rev. Met. Lit.)

6997 EFFECT OF GAS CONTENT ON THE TENDENCY TO DELAYED FAILURE AND COLD CRACKING WHEN WELDING CERTAIN TITANIUM ALLOYS. Meshcheryakov, V. N.; Shorshorov, M. Kh., Florinskii, Yu. B. Weld. Prod. (USSR) (Engl. Transl.), 13: No. 11, 20-3(Nov. 1966).

The effects of oxygen content (0.13 to 0.45%) and hydrogen content (0.002 to 0.015%) on delayed fracture of Ti alloys of the Ti–Al–Zr system were investigated. Specimens of base metal were tested as well as argon arc welded specimens. Susceptibility to delayed fracture was determined according to minimum fracturing stress, shortest time to fracture and amount of plastic deformation before beginning of fracture as determined by relative reduction of specimen in the notched section. Creep rate in an alloy containing 0.13 to 0.14% O was 2 to 3 times higher than in an alloy containing 0.45% O. An increase in oxygen content from 0.13 to 0.14 to 0.45% at a hydrogen content of 0.002% increased the minimum fracturing stress. The capacity for plastic straining and stress relaxation remained high, both in base and weld affected metal. Increasing the hydrogen from 0.002 to 0.015% considerably lowered the fracturing stress. (Rev. Met. Lit.)

6998 INFLUENCE OF SMALL AMOUNTS OF NIOBIUM ON THE MECHANICAL PROPERTIES OF 25G2 STEEL. Volobuev, I. V. Metal Sci. Heat Treat. (USSR) (Engl. Transl.), No. 1-2, 135-6(Jan.-Feb. 1966).

A Mn steel, 25G2, was alloyed with 0.03 to 0.6% Nb and also with Ti. The steel was oil quenched and tempered at about 500°C. The influence of Nb and Ti additions on impact strength, cold shortness, tensile strength, ductility, and hardness were determined. Optimum Nb concentrations and tempering conditions were selected. (Rev. Met. Lit.)

6999 THERMAL FATIGUE OF DIE-CASTING DIES. Noesen, S. J.; Williams, H. A. Mod. Cast., 51: No. 6, 119-32 (June 1967).

The thermal fatigue life of a die casting die was found to depend primarily on its thermal conductivity, thermal diffusivity, strength, and ductility. The Coffin low-cycle fatigue equation was used to predict the fatigue life of the test materials used, which included Mo, W, Nb, H-13 die steel, and 18 Ni maraging steel. Optimum operating conditions to reduce thermal fatigue were determined. (Rev. Met. Lit.)

7000 STRENGTHENING OF Cr–Mn–Mo STEEL BY COLD PLASTIC DEFORMATION. Bannykh, O. A.; Kovalenko, O. I.; Pridantsev, M. V. Metal Sci. Heat Treat. (USSR) (Engl. Transl.), No. 1-2, 117-20(Jan.-Feb. 1966).

Tensile strength, yield strength, ductility, impact strength, hardness, and grain size of several melts of 28Kh10G8M4 high-alloy steel (10% Cr, 8% Mn, 4% Mo, and 0.28% C) were tested by subjecting them to cold work hardening by rolling of hot rolled specimens, by marforming (after quenching from 800 to 1100°C) and subsequent tempering from 100 to 500°C. A comparison was made of the effects of each work hardening procedure and of tempering temperatures on mechanical properties. Optimum work hardening and heat treatment parameters are recommended. (Rev. Met. Lit.)

7001 INFLUENCE OF MOLYBDENUM ON THE PROPERTIES OF Kh15N85 ALLOY. Kontorovich, I. E.; Voshedchenko, B. M.; Buntushkin, V. P. Metal Sci. Heat Treat. (USSR) (Engl. Transl.), No. 1-2, 21-3(Jan-Feb. 1966).

A 15% Cr–85% Ni alloy was added to 2 to 14.6% Mo by powder pressing and sintering. The produced briquets were quenched and aged at 680°C for various times. It was determined that prolonged aging and increasing amounts of Mo additions affected the formation of intermetallic compounds which enhanced the hardness of the alloy. Curves are given for aging time vs hardness, microhardness, and electrical resistance. (Rev. Met. Lit.)

7002 EFFECT OF MOLYBDENUM AND TUNGSTEN ON THE PROPERTIES OF Kh25N16G7AR STEEL. Boyarinova, A. P.; Savel'eva, T. S.; Dubrovina, A. N. Metal Sci. Heat Treat. (USSR)(Engl. Transl.), No. 1-2, 18-20(Jan.-Feb. 1966).

A Kh25N16G7AR stainless steel (25-16) was alloyed with 2.6 to 6.2% Mo and about 4% W. The joint and separation effects of W and Mo on hardness, tensile strength, ductility, impact strength, creep rupture strength, and intergranular corrosion, up to 900°C were analyzed. It was determined that maximum strength was attained by the addition of 6% Mo; minimum strength by addition of 4% W. Alloying of steel with 2.5% Mo and 4% W led to formation of intermetallic compounds and increased brittleness over the range of 700 to 1000°C. (Rev. Met. Lit.)

7003 INFLUENCE OF RARE EARTH ELEMENTS ON THE CRYSTALLIZATION OF CARBON STEEL. Popova, N. N.; Sandler, N. I.; Kovalev, G. N.; Gol'din, M. L.; Tobol'skii, M. B. Metal Sci. Heat Treat. (USSR)(Engl. Transl.), No. 1-2, 110-12(Jan.-Feb. 1966).

Killed carbon steel was alloyed with Ce group elements in quantities of 0.2 to 0.4% in an induction furnace. The specimens were analyzed for sulfur distribution with the aid of metallography and autoradiography (S-35 isotope). It was determined that additions of 0.2% Ce lead to migration of sulfur from the grain boundaries into the grain bodies, thus increasing ductility and impact strength, while additions of 0.4% Ce result in concentration of harmful sulfur segregates on the grain boundaries. (Rev. Met. Lit.)

7004 PLASTIC PROPERTIES OF THIN-SHEET MOLYBDENUM AT VARIOUS DEFORMATION RATES. Shcheglov, B. A.; Mutovin, V. D.; Grushevskii, A. V. Kuchnechno-Shtampovochnye Proizvod., No. 2, 18-19(Feb. 1967). (In Russian).

Tensile strength, elongation and deep drawability have been determined for 0.5 mm thick sheet of Mo prepared by powder metallurgy. The sheet has been hot rolled in the range from 1250° to 400°C, then cold rolled and subsequently annealed at 850°C without recrystallization, or at 1250°C with recrystallization. Stress strain diagrams are presented for each annealing temperature. The recrystallization annealing resulted in decreased strength and increased ductility. (Rev. Met. Lit.)

7005 NICKEL–CHROMIUM ALLOYS WITH NIOBIUM. Sveshnikova, G. A. Metal Sci. Heat Treat. (USSR) (Engl. Transl.), No. 1-2, 32-7(Jan.-Feb. 1966).

A Ni-20% Cr alloy, alloyed with 4-9.6% Nb, was water quenched from 1200°C and aged from 500 to 1000°C for various durations. A relationship was established between hardness and creep rupture strength of alloys and aging temperatures and concentration of Nb. It was determined that additions of 6 to 9.6% Nb render the alloy dispersion hardenable. Tensile strength and ductility of Ni–Cr–Nb alloys from 20 to 900°C are graphically illustrated. (Rev. Met. Lit.)

7006 MANUFACTURE AND PROPERTIES OF MOLYBDENUM. Joly, F. Tech. Mod., No. 6, 247-50(June 1966). (In French).

The physical, mechanical, and chemical properties of Mo are listed. A selection of its applications showed the metal's suitability for electrodes and heat resistant aircraft components. It can be worked, formed, and machined like steel, but requires care in joining, brazing, and welding. It oxidizes readily and needs protective coatings in high-temperature applications. (Rev. Met. Lit.)

7007 CHEMICAL VAPOR DEPOSITION OF TUNGSTEN–MOLYBDENUM–RHENIUM TERNARY ALLOYS. Fairchild, C. I. (Los Alamos Scientific Lab., N. Mex.). pp 149-59 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

Coatings of W–Mo–Re alloy compositions were deposited onto Cu or Mo substrates by the H_2 reduction of mixed WF_6, MoF_6, and ReF_6 gases at temperatures from 550 to 800°C and subatmospheric pressures of 10 to 200 torr. The volumetric ratio of H_2-to-total fluoride was standardized at 10/1. Alloy compositions studied were in the range 60 to 85 W, 15 to 40 Mo, and 1 to 25 Re. Chemical analyses were used to determine overall and longitudinal compositions and electron microprobe analyses to determine radial concentrations of each element. Microstructural features of the coatings were determined metallographically. The microstructure of alloy deposits changed with deposition temperature from a dense, small-grained structure at 600°C to a porous, large-grain structure at 800°C. Interruptions in flow or large fluctuations in temperature and pressure caused a clearly defined layered deposit. Electron microprobe examination showed that high concentrations of Mo occurred at some interfaces of the layered structure. Chemical and metallographic analyses indicated that homogeneous, ternary alloy deposits in the range studied can be obtained reproducibly on short cylindrical surfaces (½-in. long) at 650°C and 10-torr pressure. (auth)

7008 EVALUATION OF CHEMICALLY VAPOR DEPOSITED TUNGSTEN AS ELECTRON EMITTERS FOR NUCLEAR THERMIONIC APPLICATION. Yang, L.; Hudson, R. G. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). pp 329-48 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

Various factors controlling the magnitude and the stability of the electron emission properties of chemically vapor deposited

tungsten emitters for nuclear thermionic application were studied by means of vacuum electron emission measurements, thermionic emission microscopy, and neutron activation and postirradiation annealing studies of material transport rates. Tungsten exhibiting {110} preferred crystal orientation, deposited by the hydrogen reduction of WCl_6, had a higher vacuum work function than tungsten exhibiting {100} preferred crystal orientation, deposited by the hydrogen reduction of WF_6 (e.g., 5.0 vs 4.5 eV). Duplex tungsten consisting of {110} oriented chloride tungsten emitting surface deposited on {100} oriented fluoride tungsten substrate could maintain mechanical, structural, and emission stability at 2073°K over a testing period of 1000 hr. Thermal etching in vacuum at temperatures up to 2673°K had no effect on the vacuum work function of either the chloride tungsten or the fluoride tungsten. Chemical or electrochemical etching of fluoride tungsten led to the formation of microfacets and a gain in vacuum work function of less than a few tenths of an electron volt. Both the microfacets and a part of the gain in vacuum work function vanished on heating at 2073°K for a few hundred hours. Chemical or electrochemical etching of chloride tungsten had no beneficial effect on its vacuum work function. The transport rates of fuel components from UO_2 and 90UC–10ZrC through fluoride tungsten cladding are shown to be finite at 2073°K or higher temperatures, but the vacuum work function of the tungsten surface may not be affected unless the rate of arrival by diffusion becomes higher than the rate of removal by vaporization. Cladding temperature, fuel stoichiometry, and nature of the fuel material are influential factors in determining the vacuum work function of the tungsten emitting surface. Postirradiation appealing studies of fluoride tungsten clad UO_2 and 90UC–10ZrC detected no transport of fission gases through the cladding at 2073°K. Ruthenium fission-product isotopes, however, diffused from these fuel materials through the cladding at a measurable rate at 2073°K, which may have an effect on the electrode work functions in converters operating continuously in a reactor at an emitter temperature of 2073°K. (auth)

7009 SOME EFFECTS OF FLUORINE CONTENT ON THE PROPERTIES OF CHEMICALLY VAPOR DEPOSITED TUNGSTEN. Festa, J. V.; Danko, J. C. (General Electric Co., Pleasanton, Calif.). pp 349-61 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

A preliminary investigation was performed to determine the effects of fluorine content on some of the properties of tungsten produced by the hydrogen reduction of tungsten hexafluoride (WF_6). A correlation between the as-received micro-hardness [Knoop Hardness Number (KHN)] of the tungsten and the fluorine content was established with hardness increasing with increasing fluorine content. Tungsten with fluorine contents greater than 20 ppM exhibited dimensional changes at high temperatures (1750 to 2500°C), which increased with increasing fluorine content. The dimensional changes were temperature and time dependent. The grain-growth characteristics of the tungsten also were related to the fluorine content. At lower fluorine contents there was a greater tendency for grain growth, whereas, with higher fluorine levels, grain growth was inhibited by the formation of grain-boundary bubbles. (auth)

7010 MECHANICAL BEHAVIOR OF CVD TUNGSTEN AT ELEVATED TEMPERATURES. McCoy, H. E.; Stiegler, J. O. (Oak Ridge National Lab., Tenn.). pp 391-425 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

Many applications of CVD tungsten require that the material be stressed at elevated temperatures. Creep-rupture tests were run at 1650 and 2200°C to evaluate the mechanical behavior of this material, and the properties are compared with those of a typical heat of powder metallurgy tungsten. At 1650°C, the CVD product had low fracture strains (approximately 5%) and a lower minimum creep rate. At high stresses, the rupture life was shorter than that of the PM material; at low stresses, the rupture lives were about equivalent. At 2200°C, the minimum creep rate was higher and the rupture life lower for the CVD product. Two microstructural features of importance were noted in the CVD tungsten: the formation and growth of voids; and the columnar nature of the grains. Fractographic techniques were used to study void nucleation and growth in the material. Nucleation appeared to be spontaneous as the material was heated to elevated temperatures, indicating the presence of an impurity having a high vapor pressure. The growth appears to occur almost entirely by the stress-induced diffusion of vacancies into the void. At 2200°C, under stress the voids reach such a large size that they comprise about 10% of the test specimen. The columnar grain structure of the material is important because it is very difficult to get extensive grain-boundary sliding and rotation in this type of structure. We have rationalized the creep behavior of this material on the basis of the effects that both the void growth and the columnar grain structure have on the individual deformation processes that sum to give the overall creep behavior. (auth)

7011 CVD TUNGSTEN AND TUNGSTEN–RHENIUM ALLOYS FOR STRUCTURAL APPLICATIONS. PART II. EVALUATION. Holman, William R.; Huegel, Frank J. (Univ. of California, Livermore). pp 427-58 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

The effects of several deposition variables and heat treatments on the room-temperature mechanical properties of CVD tungsten and tungsten-rhenium alloy tubing were determined. Tubes selected from the process-development program were sectioned into small ring-shaped specimens, heat-treated, and tested to failure in uniaxial tension. Yield strength, ultimate tensile strength, and uniform elongation were determined with a hydraulic ring tester developed specifically for this application. Tensile strengths as high as 150,000 psi were obtained with unalloyed tungsten deposits. Measurable ductility was observed in a fine-grain deposit after a stress relief anneal at 1000°C. Ultimate tensile strengths exceeding 200,000 psi and uniform elongations as high as 2% were obtained with co-deposited, tungsten-rhenium alloys. The results indicate that deposits with mechanical properties approaching those of wrought material can be obtained by chemical vapor deposition. (auth)

7012 OXYGEN EFFECTS ON THE KINETIC ELECTRON EMISSION. Arifov, U. A.; Dzhurakulov, Kh.; Rakhimov, R. R. (Physical-Technical Inst., Tashkent). Dokl. Akad. Nauk. Uzb. SSR., No. 6, 16-18(1967). (In Russian).

The effects of oxygen adsorption on polycrystalline molybdenum and the surface oxidation effects on electron energy distribution during kinetic emission induced by neutral helium atom beam bombardment at 1.5 to 5.0 keV were studied. At the initial stages of thermal treatment the yield from the target was (6 to 7 keV). After continous thermal treatment the φ magnitude dropped and following 25-hour degassing at 2300°K the magnitude φ was 4.28 ± 0.0 ν eV; with molybdenum oxidation the φ value reached 7.1 ± 0.35 eV. The energy distribution curves for electrons emitted from pure molybdenum surfaces, oxidized surfaces, and from surfaces with helium bombardment-induced adsorbed oxygen films are analyzed. (R.V.J.)

7013 DIFFUSION OF CARBON IN NIOBIUM. Son, Pongun; Ihara, Seiichi; Miyake, Masanobu; Sano, Tadao (Osaka Univ.). Nippon Kinzoku Gakkaishi, 31: 998-1001(1967). (In Japanese).

The diffusion coefficients of carbon in niobium were studied by tracer techniques using ^{14}O at 930 to 1800°C. The diffusion coefficients are described by the equation, $D = D_0 \exp(-E/RT)$ where D_0 and E are 0.033 cm^2/sec and 37.9 kcal/mol, respectively. (auth)

7014 STAINLESS-STEEL FILTERS FOR NUCLEAR APPLICATIONS. Bishop, E.; Collins, G. (BSA Sintered Components, Ltd., Birmingham, Eng.). Powder Met., 10: 192-202 (Autumn 1967).

From Symposium on the Role of Powder Metallurgy in Nuclear Technology, London, Nov. 16–17, 1967. See CONF-671108.

Porous stainless steel (Type En58e or AISI 304L) is now an accepted material for numerous specialized purposes in chemical engineering, notably filtration. It has excellent resistance to corrosion and can be used at relatively high temperatures. Typical applications in the nuclear energy field are described, where corrosion resistance and good strength at elevated temperatures of porous stainless steel are of great value. Some details are also given of the stopping power of the filters for solids in gases and liquids, the behavior and control of the filter cake, and the performance and life characteristics of the filter material. (auth) (UK)

7015 A NOTE ON POROUS METAL FILTERS IN NUCLEAR POWER STATIONS FOR CO_2 PURIFICATION. Harcourt, R. A. G. (Fairey Hydraulics, Heston, Eng.). Powder Met., 10: 203-7 (Autumn 1967).

From Symposium on the Role of Powder Metallurgy in Nuclear Technology, London, Nov. 16–17, 1967. See CONF-671108.

The use of bronze and chromized iron elements for filtering in the sub-micronic to 25 μ range is outlined. The filtration unit design described is capable of withstanding a pressure differential

of 100 psi. Pressure drop and filter efficiency data are included. (UK)

7016 REFRACTORY METALS (Cb, Ta, Mo, W). Van Orsdel, J., Bartlett, E. S.; Barth, V. D. DMIC Review of Recent Developments, Nov. 3, 1967. Columbus, Ohio, Battelle Memorial Inst., 1967. 6p.

The effects of processing variables on the mechanical properties of high-strength Nb-base alloys are described in detail. The effects of various fabrication techniques on the integrity of Ta as a high-temperature structural material were investigated. The mechanical properties of Mo–1.5 Nb–0.5 Ti–0.3 Zr alloy are reported. The process for the fabrication of W tubes from powders coated with a Ni–P alloy are reported, and results of studies to investigate the mechanical properties of wrought W are discussed. (21 references). (B.L.M.)

Structure and Phase Studies

Refer also to abstracts 6299, 6971, and 6994.

7017 (GA-7974) MICROSTRAIN MEASUREMENTS IN Nb FROM 1.8° TO 300°K. Firle, T. E.; Chambers, R. H. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Feb. 9, 1967. Contract AT(04-3)-167. 15p. (CONF-660327-13). Dep. CFSTI.

From American Physical Society Meeting, Durham, N. C.

A method was developed, which makes it possible to use internal-friction and modulus-defect measurements to obtain stress–dislocation–strain curves. The stress–temperature dependence shows that separate, distinctly discrete processes are operative. The activation energy for the low-temperature process (α') obtained from a separate experiment and the slope of the stress–temperature dependence lead to a stress-coupling factor (activation volume) of about 1.5 b^3. The α' process is therefore thought to be stress-assisted diffusion of individual kinks. The tendency of the slopes to approach zero as the temperature approaches zero for temperatures below 4°K is to be expected from theoretical thermodynamical arguments. (auth)

7018 (UCRL-Trans-10157) STRUCTURE AND INDUSTRIAL MANUFACTURE OF CORROSION-RESISTANT MAGNESIUM–MANGANESE ALLOYS. Schneider, A.; Stobbe-Scholder, H. Translated by B. J. Hazzard for Univ. of California Lawrence Radiation Lab., Livermore, from Metall, 4: 178-83(1950). 32p. Dep. CFSTI. JCL $3.60 fs, $1.19 mf.

The manner in which solidification of Mg-rich Mg-Mn alloys takes place is discussed. Solidification with ~2 to 100% Mn leads to the formation of primary crystals consisting of pure Mn. The peritectic reaction of these primary crystals with the remainder of the melt at about 3°C above the melting point of Mg forms the Mg-rich α mixed crystal. Mn solubility in liquid Mg is ~2% at 653° and rapidly increases with rising temperature. Mn exhibits a highly temperature-dependent solubility in solid Mg with a maximum of ~3.5% at the peritectic temperature. Solubility of mg in solid Mn is very small; far below 1%. Removal of harmful amounts of Fe in Mg-Mn alloy manufacture improves corrosion resistance. (F.S.)

7019 (UCRL-Trans-10160) MAGNESIUM–ZIRCONIUM PHASE DIAGRAM. Sauerwald, F. Translated by P. Unger for Univ. of California Lawrence Radiation Lab., Livermore, from Z. Anorg. Allg. Chem., 255: 212-20(1947). 18p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The part of the Mg–Zr phase diagram which adjoins the Mg side was determined. Mg can dissolve 0.6 to 0.7% Zr at 700 to 800°C in the liquid state and forms solid solutions with zirconium characterized by a temperature-dependent solubility curve in the solid state with solubilities falling from 4.5% to about 0. During crystallization special structures and particle size reduction effects arise. (auth)

7020 ORDERED SOLID SOLUTION IN THE CHROMIUM–MOLYBDENUM SYSTEM. Prokoshkin, D. A.; Sidunova, O. I. Izv. Vyssh. Ucheb. Zaved., Mashinostr, No. 7, 116-19(1966). (In Russian).

Three zones were revealed in a layer in Cr-plated Mo by metallographic examination and local electron probe microanalysis. The central zone has the greatest hardness (Vickers hardness 500 mg/mm^2); its etchability is poor, and it contains a concentration of 50 at. % Cr and Mo. Electron probe microanalysis of annealed powdered Cr–Mo alloys revealed tetragonal lattice lines, and other lines, which disappeared as the powder was deformed. As a result of these analyses, an ordered solid solution was found in the Mo–Cr system; this solid solution contained equal amounts of atoms of both elements. (Rev. Met. Lit.)

7021 ISOTHERMAL TRANSFORMATIONS IN TITANIUM–MOLYBDENUM ALLOYS. Kolachev, B. A.; Livanov, V. A.; Vishnyakov, D. Ya.; Lyasotskaya, V. S. Tr. Mosk, Aviats, Tekhnol. Inst., No. 66, 39-52(1966). (In Russian).

Diagrams of the isothermal transformations that take place in alloys of Ti with 2, 6, 9, and 13% Mo were plotted on the basis of metallographic, x-ray, and dilatometric analysis, and measured hardnesses. The diagrams consist of series of lines depicting the start and end of decomposition of the β- and α-prime phases for alloys containing 2, 6, and 9% Mo, and of the β-phase for the alloy containing 13% Mo. The region in which the Cu-phase exists, only found during isothermal decomposition in the case of the alloys containing 9 and 13% Mo, was plotted on the diagrams for these alloys. (Rev. Met. Lit.)

7022 STRUCTURAL TRANSFORMATIONS IN TYPE Ni_4Mo ALLOYS. Semenova, N. V.; Kostogonov, V. G.; Platova, S. N. Stal, No. 1, 81-5(Jan. 1967).

The processes of structural ordering were studied in four Ni–Mo alloys containing 24.2 to 28.6% Mo. Dispersion hardening with precipitation of the Ni_4Mo intermetallic compound and ordering was investigated. Of the four alloys, the first had a stoichiometric composition with formation of superlattice after heating to 600°C and cooling in air. The second alloy contained disordered and ordered solid solution at temperatures below 800°C. The third and fourth alloys were additionally alloyed with Cr and Al, but had Ni and Mo contents similar to the first two alloys. Forged ingots were drawn into rods which after softening heat treatment were drawn into 0.8-mm diam wire. Temperature dependence of electrical resistance was studied during heating in a tubular furnace. Heat treated (to 1200°C, holding 1 hr and water cooling) specimens were studied by dilatometric analysis. Microstructure was analyzed after etching in Marble's reagent. X-ray diffraction analysis was conducted by the photo method. Maxima appeared on the electrical resistance temperature dependence curves for the binary Ni_4Mo alloys during heating or cooling. The formation of the maxima was caused by the occurrence of the initial stages of ordering. (Rev. Met. Lit.)

7023 PREPARATION AND SOME PROPERTIES OF TUNGSTEN–RHENIUM–OSMIUM ALLOYS. Leach, A.; Jones, D. J. (General Electric Co., Ltd., Wembley, Eng.). Powder Met., 10: 174-91(Autumn 1967).

From Symposium on the Role of Powder Metallurgy in Nuclear Technology, London, Nov. 16–17, 1967. See CONF-671108.

Two series of W–Re–Os alloys were successfully prepared by powder-metallurgy techniques in sintered bar form. The first series, containing nominally 5% Re and up to 2.25% Os, are single-phase alloys consisting of an α solid solution. The second series, containing nominally 26% Re and up to 11.3% Os, consist of the same solid solution up to ~1.67% Os, whereas the higher osmium contents give two-phase alloys consisting of the α solid solution and the hard, brittle σ phase. The two-phase alloys are of the age-hardenable type and their properties are thus dependent on the thermal history. The alloys containing ~26% Re and between ~0.69 and 4.5% Os are particularly prone to deformation twinning at room temperature, the tendency reaching a maximum at ~1.67% Os. This observation may be interpreted as an extension of the rhenium alloying effect, the double addition of rhenium and osmium giving an interactive as well as additive effect of Os atoms. Confirmation of the lower energy of the twinning planes is also apparent from the mode of precipitation of the σ phase on preferential planes in this composition range. (auth) (UK)

7024 FLUORESCENT X-RAY DETERMINATION OF TIN, IRON, NICKEL, AND CHROMIUM IN ZIRCALOY-2 AND ITS APPLICATION TO THE HOMOGENEITY CHARACTERIZATION OF JAERI ZIRCALOY-2 STANDARD SAMPLE. Nakajima, Atsunosuke; Takashima, Kyoichiro; Ito, Shoichi (Japan Atomic Energy Research Inst., Tokyo). Nippon Kinzoku Gakkaishi, 31: 993-8(1967). (In Japanese).

The distribution of Cr, Fe, Ni, and Sn in JAERI Zircaloy-2 was determined by electron-probe analysis. A standard sample of Zircaloy-2 from NBS was used as a check. It was determined that inhomogeneity of Sn was present in an individual disk in both the JAERI and NBS Zircaloy specimens and was caused by very small variances in the x-ray fluorescence of Sn. It was also concluded that distributions of Cr, Fe, and Ni were homogeneous since their variations were larger. Electron-probe microanalysis showed that the inhomogeneity of Sn distribution was not due to local concentration. (P.G.C.)

Radiation Effects

Refer also to abstracts 6318, 6338, and 7897.

7025 STUDY OF THE MECHANISM OF PLASTIC DEFORMATION IN UNIRRADIATED AND IRRADIATED LOW-CARBON STEEL. Milasin, Nada. Bull. Boris Kidric Inst. Nucl. Sci., 17: 255-73(Oct. 1966).

The activation volume ν^* defined by $\nu^* = kT\,(\partial \ln\gamma/\partial\tau^*)_T$ was determined before and after irradiation in a very low carbon steel. The dependence between ν^*/b^3 and the effective shear stress τ^* shows that Peierls' mechanism of plastic deformation operates at temperatures lower than about −50°C. After irradiation the activation volume at all temperatures showed values which differ from unirradiated specimens, thus indicating a change in the mechanism of deformation, induced by irradiation. The temperature dependence of σ_y was also measured before and after irradiation. The results showed that the slope of the σ_y Vsθ curve changed after irradiation, supporting the conclusions made on the basis of the activation volume measurements. "Thermal hardening" was found in specimens annealed between 100 and 350°C after irradiation. The temperature dependence of σ_y after thermal hardening indicated that in this case only the internal friction changes, i.e., that the thermally activated process induced by irradiation disappears. (auth)

7026 FISSION FRAGMENT DAMAGE TO METALLIC CRYSTALS. I. SINGLE CRYSTAL GOLD. Van Vliet, D.; Chadderton, L. T. (Cavendish Lab., Cambridge, Eng.). Phil. Mag., 16: 275-90(Aug. 1967).

Electron microscope observations of thin gold films irradiated with fission fragments revealed the presence of small defect clusters. A comparison between the characteristics of their formation and growth at low doses with theoretical predictions indicated that these clusters are due to depleted zones, localized vacancy-rich regions created in situ by individual energetic primary or secondary knock-ons. Dark-field microscopy showed that the majority of clusters are Frank loops (Burgers vector $\frac{1}{3}\langle 111\rangle$), but a small fraction of perfect loops (Burgers vector $\frac{1}{2}\langle 110\rangle$ is also found. Individual visible clusters contain between approximately 40 and 1100 vacancies. The implication of these results on the more general question of fission fragment damage in thin metal films is discussed. (auth)

7027 POSSIBLE FAST-REACTOR CANNING MATERIAL STRENGTHENED AND STABILIZED BY DISPERSION. Huet, J. J. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Powder Met., 10: 208-15(Autumn 1967).

From Symposium on the Role of Powder Metallurgy in Nuclear Technology, London, Nov. 16–17, 1967. See CONF-671108.

The high-temperature irradiation embrittlement of steels and nickel alloys is probably due to helium precipitation in grain boundaries. It would be desirable to retain the helium as fine bubbles evenly distributed within the grains. A fine dispersion in the metal matrix may act as a nucleation site for helium bubbles, and it is proposed to produce by powder-metallurgy techniques a fine dispersion of a ceramic oxide in a steel matrix. Ferritic chromium steel was chosen because it is known to be less susceptible to embrittlement than austenitic alloys, and in this case the oxide dispersion must also improve the high-temperature mechanical properties. Methods of preparation are discussed, and results of preliminary tensile tests performed on iron containing alumina, magnesia, and titania dispersions indicate the feasibility of the proposed solution. (auth) (UK)

Ceramics and Cermets

Refer also to abstract 6933.

7028 SCIENCE OF CERAMICS. VOLUME 3. Proceedings of the Third Conference of the British Ceramic Society and the Nederlandse Keramische Vereniging held at Bristol, Eng., July 5–8, 1965. Stewart, G H. (ed.). London, Academic Press, 1967. [335p.]. (CONF-650729–(Vol.3)). DTIE.

Twenty articles are included; separate abstracts were prepared for 4. The remaining 16 articles include information on: indialite and barium osumilite in fired bodies; structures of $AlPO_4$ and SiO_2; structure of silicon nitride; measurement of specific surface of clays and its application; crystallization processes in aluminum hydroxide gels; aging of plaster of paris in relation to its equilibrium water-content; effects of quartz on hydration of $3CaO \cdot Al_2O_3$; phase equilibrium studies; the equilibrium index; solid state equilibria in calcium oxide–barium oxide–silica; phase relations in $CaO-Al_2O_3-Fe_2O_3$; method for calculating rates of reaction; formation of ferrites from the metal oxides; exsolution phenomena in polycrystalline oxide systems; constitution of bone china; and interrelationship of phase equilibria, microstructure, and properties in fusion-cast ceramics. (P.C.H.)

Corrosion and Erosion

7029 OXIDATION OF U_4O_9 DURING HEATING IN AIR. Bessonov, A. F.; Semavin, Yu. N.; Taksis, G. A. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met., No. 2, 100-2(1967). (In Russian).

U_4O_9 was obtained by homogenizing a mixture of UO_{2+x} and U_3O_8 at 900 to 950°C for 80 hr. Phase homogeneity was determined by x-ray phase analysis. The oxide was pressed into a specimen tablet. To study processes occurring at high temperatures, a high-temperature installation was developed, which made it possible to obtain simultaneously, from a single specimen, an x-ray, a curve showing electrical resistance, a curve showing changes in linear dimensions, and a thermogram. During transition from U_4O_9 to U_3O_7, the interplanar distance decreased considerably. The oxidation of U_4O_9 into U_4O_7 is accompanied by an exothermic effect, and the transformation of U_3O_7 into U_3O_8 is related to the growth in electrical resistance and size of the specimen. (Rev. Met. Lit.)

7030 PROTECTIVE COATINGS FOR REFRACTORY MATERIALS. Buckle, H. Tech. Mod., No. 5, 51-9(May 1965). (In French).

The use of new alloys of W, Ta, Mo, Nb, capable of withstanding higher temperature than the superalloys, poses the problem of protecting them against corrosion under practical conditions. So far, $MoSi_2$ is the most effective Mo-coating, lasting 1000 hrs at 1200°C but the effectiveness of cooling and other devices in solving re-entry problems has decreased the incentive to develop coatings. Research is now directed toward light and stable coatings of high emissivity, with resistance up to 2000°C for 1 hr, mainly for atmospheric re-entry of future missiles. (Rev. Met. Lit.)

7031 SINTERING OF PYROPHORIC POWDERS. Russell, L. E. (Atomic Energy Research Establishment, Harwell, Eng.). Powder Met., 10: 239-63(Autumn 1967).

From Symposium on the Role of Powder Metallurgy in Nuclear Technology, London, Nov. 16–17, 1967. See CONF-671108.

The room-temperature oxidation behavior of reactive metal and ceramic powders is reviewed and it is shown that many materials under normal circumstances oxidize to give a limiting film thickness of ~50 Å. Since the thickness of oxide films has an important bearing on sintering characteristics the control oxidation may be essential for some materials and desirable for others. The oxidation behavior of uranium carbide and uranium nitride in various concentrations of oxygen and water vapour in argon is described, and its effects on the sintering behavior and composition changes that take place during sintering are considered. Suitable handling conditions for these materials are provided by glove-boxes filled with argon. The application of high-purity atmospheres in the preparation, handling, and sintering of tungsten powders gave pellets with densities of 95% theoretical and oxygen contents <10 ppM after sintering in hydrogen at 1550°C. (auth) (UK)

Preparation and Fabrication

Refer also to abstracts 6940, 6943, 6950, 6951, 6966, and 7031.

7032 (NUMEC–3524-43) DEVELOPMENT AND TESTING OF PuO_2–UO_2 FAST REACTOR FUELS. Progress Report, July 1–September 30, 1967. (Nuclear Materials and Equipment Corp., Apollo, Pa.). Oct. 1967. Contract AT(30-1)-3524. 25p. Dep. CFSTI.

A method of density control for ceramic fuels is described which consists of adding a quantity of the fuel precursor to the ceramic fuel powder in the blending-prior-to-pressing step and firing in the normal sintering cycle. Test results using 5 to 20% fuel precursor of $Pu(OH)_4$-ADU are presented. Determination of homogeneity by autoradiography for fuel consisting of 2 and 3 wt % of 100μ PuO_2 microspheres blended with the base oxide of 20% PuO_2-UO_2 is described. Transverse section autoradiograph results of the mixing procedures are presented. (D.C.C.)

7033 ADHERENCE TO CERAMIC COMPONENTS OF METAL LAYERS WHICH ARE DIFFICULT TO SEAL. Rochow, H. Ber. Deut. Keram. Ges., 44: 224-31(May 1967). (In German).

A survey is given of the generally accepted views on the adherence mechanism of Mo coatings on Al_2O_3 bodies applied by the so-called Mo–Mn method. Experiments (based on these views) are described on Ni-plating of steatite bodies. Particular reference is made to the question of the wetting of steatite bodies and various metals by certain molten oxides. (Rev. Met. Lit.)

7034 PREPARATION OF BORIDES BY MEANS OF BORON TRIFLUORIDE. Pichat, Philippe (Lyon Univ.). Compt. Rend., Ser. C, 265: 385-7(Aug. 7, 1967). (In French).

The thermodynamic aspect of the action of Al, Mg, Ca, Ti, and Zr on boron trifluoride was considered at 500 to 2,500°K. With Al

at 1,200°C a tetragonal compound was obtained. Its x-ray diffraction spectrum has characteristics intermediate between those of α-AlB_{12} and that of a tetragonal form of B described by Talley. By temperature increase these phases were transformed into rhombohedric β-boron. At 1,600°C the formation of the calcium hexaboride, titantium diboride, and zirconium diboride was observed with Ca, Ti, and Zr, respectively. (tr-auth)

7035 METALLIC-FIBER-REINFORCED HEAT-RESISTANT CERAMIC MATERIALS. Chvatal, Theodor. Sprechsaal Keram. Glas Email Silikate, 100: No. 5, 181-5(1967). (In German).

The preparation and testing of fiber reinforced, rammed ceramic materials are described. The material consists of a ramming mass of 46% corundum (grain size 36), 46% corundum (240), and 8% alumina with Al–Cr–phosphate as the binder. The reinforcing filaments are Kanthal A (22% Cr and 5% Al) and Nicrothal (80% Ni and 20% Cr). It was found that unless the wire is applied in helical shapes, it slips within the ceramic mass during mechanical testing. As little as 1 vol % wire significantly improved the properties of the ceramic material. Bending tensile and tensile strength were increased and the room temperature compressive strength was not affected. Resistance to thermal shock and thermal fatigue increased greatly and applications to 1450°C were possible. Applications in nuclear reactors, space vehicles, and the steel industry (furnace linings) are outlined. (Rev. Met. Lit.)

7036 THE ROLE OF OXYGEN/METAL RATIO DURING THE SINTERING AND OXIDATION OF SOME URANIUM–PLUTONIUM OXIDES. Adwick, A. G.; Reilly, W. S. C. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). pp 215-35 of Science of Ceramics. Vol. 3. Stewart, G. H. (ed.). London, Academic Press, 1967.

From 3rd Conference of the British and Holland Ceramic Society, Bristol, Eng., July 5–8, 1965. See CONF-650729–(Vol.3).

Non-stoichiometry in co-precipitated U-rich solid solutions and its influence on sinterability, theoretical density, and the oxidation behavior are discussed. Powders with initial oxygen/metal ratios between 2.00 and 2.46 were sintered in argon and in hydrogen. Density data show that the behavior of $(U,Pu)O_{2+x}$ in argon is similar to that of UO_{2+x}. In hydrogen, however, the near-stoichiometric compositions ultimately yield the highest densities. The oxygen/metal ratio effects may be explained either by the low-temperature formation of large closed pores or by the enhanced sinterability of sub-stoichiometric oxide. Oxygen from unreduced precipitate has a more deleterious effect on density than interstitial oxygen introduced by oxidation of fully reduced oxide. Plots of lattice parameter against oxygen/metal ratio tend to deviate positively from the theoretical relationship. Sintered-pellet oxygen/metal ratios (1.92 to 2.10) did not change during six months' exposure to air at room temperature. At 100°C there was a gradual conversion of the sub-stoichiometric pellets to stoichiometric compositions. Oxidation/temperature curves were determined by thermobalance. (auth)

7037 PARTICLE GROWTH BY CONTROLLED FLOCCULATION. Hermans, M. E. A. (EURATOM–RCN–KEMA, Arnhem, Netherlands). pp 65-74 of Science of Ceramics. Vol. 3. Stewart, G. H. (ed.). London, Academic Press, 1967.

From 3rd Conference of the British and Holland Ceramic Society, Bristol, Eng., July 5–8, 1965. See CONF-650729–(Vol.3).

A method is presented for obtaining precipitates of controlled particle size by controlling the colloid chemical conditions of the system and the maximum shear rates in the liquid. The precipitate particles have the shape of compact agglomerates, and the phenomena observed are explained. The mechanism was discovered during the precipitation of U^{6+} with urea at 85 to 110°C, but its applicability is much wider. (auth)

7038 MACHINING OF GRAPHITE. Marmillon, R. Tech. Mod., No. 7, 37-42(July 1965). (In French).

The use of synthetic graphite elements in atomic piles of the graphite–gas type has led to an increase in its production. Machining was first done on conventional machines, but the fragility of the material soon required special treatment: high speeds of 500 to 2000 rpm, avoidance of reciprocating action, and efficient dust removal. High production rates make it necessary to provide ample storage space. A sampling of the special-purposes machines is described. Although they generally resemble conventional machine-tools, their peculiarity is related to their lay-out and construction details have been specially adapted to the requirements of the material to be processed. (Rev. Met. Lit.)

7039 THERMODYNAMIC AND KINETIC ANALYSIS OF CHEMICAL VAPOR DEPOSITION. Burson III, John H.; Fleming, J. D. Jr. (Georgia Inst. of Tech., Atlanta). pp 57-71 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

Chemical vapor deposition reactions are generally complex in terms of reaction mechanism and are not amenable to rigorous theoretical analyses. Application of the basic principles of chemical thermodynamics and reaction kinetics, however, can be used to advantage in directing initial stages of research on vapor plating and providing guidance for any subsequent efforts. The advantages and applications of this approach are discussed and the basic relations necessary for such calculations are presented. Thermochemical calculations based on elementary data such as free energies of formation are used to predict reaction feasibilities, to indicate possible formation of undesirable intermediates, and to determine limiting effects of operating parameters such as temperature, pressure, and ratio of reactants. Maximum yields based on equilibrium considerations are also considered. The processes of adsorption and desorption are discussed as possible rate-determining steps for surface reactions. Kinetic expressions are developed for several unimolecular and bimolecular reactions with various degrees of surface coverage. The dependence of reaction rate and temperature are discussed in terms of the Arrhenius relationship and methods for determining activation energies are presented. The type of calculations involved for this approach and typical results that may be obtained are illustrated by examples that were chosen from chemical vapor deposition systems presently in use. (auth)

7040 MECHANISMS OF EPITAXIAL GROWTH OF COMPOUNDS BY CHEMICAL VAPOR DEPOSITION. Weinstein, Martin; Wolff, G. A. (Tyco Labs., Inc., Waltham, Mass.). pp 99-106 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

The basic mechanisms of heterogeneous kinetics in epitaxial film growth are discussed. It is shown that significant information may be obtained by utilizing the close relation between crystal-form morphology of epitaxial films and the variety of conditions governing their growth. Variations in vapor-phase composition, temperature, and other growth parameters are often accompanied by a change in crystal-form morphology. Such a change in crystal-form morphology directly indicates a basic change in the kinetics of film formation. By proper control of vapor supersaturation, vapor species and substrate crystallography changes in growth mechanism may be controlled to produce desirable metastable modifications of various compounds. The strong effect of substrate crystallography is emphasized. The epitaxial growth of compounds such as CdS, SiC, and GaP by chemical reaction vapor transport techniques is discussed. Electron microscopy and electron microprobe investigations have been utilized to ascertain the chemical and physical nature of the epitaxial interface. In these systems, vapor etching in conjunction with epitaxial growth runs has aided in the analysis of the associated steps in these processes and the kinetics at the crystal surface. (auth)

7041 CHEMICAL VAPOR DEPOSITION OF IRIDIUM. Macklin, B. A.; Withers, J. C. (General Technologies Corp., Reston, Va.). pp 161-73 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

An investigation has been undertaken to select the most promising compound for vapor depositing iridium coatings on selected graphites for oxidation protection to 2000°C. Box statistical experimental design methods were used to evaluate the deposition parameters of substrate temperature, gas flow, pressure, gas composition, vaporization temperature, and wall temperature for the various iridium compounds and to select optimum deposition conditions. The compounds investigated include iridium trichloride, iridium tetrachloride, iridium tribromide, and iridium hexafluoride. It was found that deposition from the halides could occur by three mechanisms. Direct pyrolysis occurs at 800 to 1000°C, hydrogen reduction begins at 700°C, and deposition temperatures as low as 250°C can be used with π- or σ-bonding ligands. When using carbon monoxide as the ligand, the mechanism involves volatile intermediates of iridium carbonyl halides, whereas with water as the additive, hydrated intermediates are postulated. Iridium hexafluoride was found to be the best halide for depositing iridium coatings; however, the by-products of the reaction can cause problems by reaction with the graphite substrate. Although iridium hexafluoride is the best choice for rapidly depositing irid-

ium coatings, iridium trichloride or tribromide can also be used satisfactorily. Additionally, two organometallic compounds, iridium acetylacetonate and biscyclopentadienyl iridium hydride, can be used to vapor deposit iridium when reactive reaction products cannot be tolerated. Such chemicals are not available commercially but can be specially synthesized. Iridium coatings were vapor deposited on graphites with a range of thermal expansions and porosites. Thick coatings, which provide good oxidation protection to 2000°C on AXM5Q graphite, have been built up by vapor deposition and electrodeposition. (auth)

7042 CHEMICAL VAPOR DEPOSITION OF CERAMIC COMPOUNDS. Heestand, R. L.; Short, D. W.; Robinson, W. C. (Oak Ridge National Lab., Tenn.). pp 175-91 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

The feasibility of the chemical vapor deposition process as a means of direct conversion of uranium halides to refractory uranium compounds and as a means of fabricating research hardware of SiC, B_4C, and BN was studied. It has been found that the stoichiometry and the physical characteristics of deposits may be controllably changed by varying the deposition parameters. For example, BN appears as milky white, chocolate brown, or transparent, according to the deposition technique. Strips of the transparent BN have been prepared. The surface finish of the as-deposited SiC is also a function of deposition parameters and can be varied from a rough crystalline surface to a smooth finish that requires no additional machining. The morphology of the UO_2 deposition product can be predictably varied from a 60- to 200-Å-dia powder to a theoretically dense free-standing deposit by proper control of process parameters. With this versatility, specific properties may often be obtained to fit the needs of a particular application. The general nature of the systems studied to date indicates that chemical vapor deposition may be applied to other refractory compound systems to produce coatings or free-standing bodies through the application of similar techniques. (auth)

7043 RADIANT ENERGY REACTOR TECHNIQUE FOR THE DEPOSITION OF SiC ONTO QUARTZ FILAMENTS. Saunders, E.; Weinstein, Martin; Mlavsky, A. I. (Tyco Labs., Inc., Waltham, Mass.). pp 217-27 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

Several techniques are described for radiantly heating a fiber substrate without heating the reactor wall. A double elliptical mirror furnace, using line-source tungsten infrared lamps, has been found capable of producing temperatures of 1200 to 1300°C on the surface of a 5-mil-dia quartz fiber. High modulus dense stoichiometric silicon carbide has been deposited on quartz from methyl trichlorosilane to a thickness of several substrate diameters, at rates up to about 1 mil/min. Extension of the radiant deposition technique to other shapes, including tape and sheet geometries, is discussed briefly. Results indicate that radiant heating can be a powerful technique for the preparation of coatings and structures by chemical vapor deposition. (auth)

7044 VAPOR DEPOSITION OF TUNGSTEN–RHENIUM ALLOYS ON URANIUM DIOXIDE SPHEROIDS IN A FLUID-BED REACTOR. Hamrin, C. E. Jr.; Foster, E. M. (Union Carbide Corp., Oak Ridge, Tenn.). pp 243-62 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

Tungsten-rhenium alloys were used to coat UO_2 spheroids in a fluid-bed reactor by chemical vapor deposition. The UO_2 was screened, weighed, and charged into the reactor. After the reactor was sealed, checked for leaks and purged, tungsten hexafluoride was introduced with He sweep gas. Coating rates are reported in terms of microns/hr and g metal/hr. Plating efficiency defined as the ratio of W or Re deposited on the heads to that available in the WF_6 or ReF_6, was calculated. (F.S.)

7045 NEW TECHNIQUE FOR METAL COATING OF SUB-MICRON PARTICLES. Please, C. M. (Bell Telephone Labs., Inc., Reading, Pa.). pp 263-71 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

A technique known as liquid bed coating, devised to allow metal coating of discrete particles having major dimensions less than 5μ is described. Prior work on such fine powders has established a practical lower limit as particle size >5μ, set by agglomeration, when conventional forms of vapor plating are used. The liquid bed coating technique has been demonstrated to allow metal coating of inorganic crystallites in the size range 10 to 0.1 μ, suspended in an inert liquid. There are no indications of any lower limit on particle size. Particles are coated uniformly and without detectable agglomeration. Reproducibility of the process is achieved by control of time, temperature, and reagent concentration. Application of nickel films to inorganic crystallites is discussed with reference to suspending media, powder handling techniques, and the chemical purity of the product. Extensions to refractory metal-ceramic systems and the utility of the method in device technology are examined with reference to two simple electronic devices. (auth)

7046 COMMERCIAL CHEMICAL VAPOR DEPOSITION OF REFRACTORY MATERIALS. Withers, J. C.; McCandless, L. C.; Macklin, B. A. (General Technologies Corp., Reston, Va.). pp 315-27 of Proceedings of the Conference on Chemical Vapor Deposition of Refractory Metals, Alloys, and Compounds, Gatlinburg, Tennessee, September 12–14, 1967. Schaffhauser, A. C. (ed.). Hinsdale, Ill., American Nuclear Society, Inc., 1967.

See CONF-670905.

Refractory materials such as boron, silicon carbide, boron carbide, boron silicide, and titanium diboride were applied in pilot and production coating systems to wire substrates to form continuous-filament materials. Other metals such as tungsten, molybdenum, nickel, aluminum, and iridium were used to coat irregularly shaped parts and, in some instances, to form tubes, nozzles, and sheets. A full-scale production system for fabrication of silicon carbide filaments is described and the physical and mechanical properties of the resultant filament are enumerated. Variation in both reaction routes and deposition equipment are cited for the formation of other refractory compounds such as boron carbide, titanium diboride, and boron silicide. Details on deposition equipment and procedures are given for producing specific geometrical shapes such as sheets, tubes, etc. Unique designs were developed wherein small parts can be inserted, cleaned, and removed from the reactor chamber without exposure or disruption of the coating operation. The equipment and processing procedures for applying coatings and forming components of boron, tungsten, and silicon carbide are described. (auth)

7047 STUDIES OF DIRECT EXTRUSION OF RODS WITH METAL CERAMIC CORE IN ALUMINUM CLADDING. Rutkovski, Vladyslav; Shteke, Vitol'd; Vecherkovski, Mar'yush. Nukleonika, 12: 959-64(1967). (In Russian).

The technology of EK-10 fuel elements was analyzed and various methods of fabrication by direct extrusion of fuel elements containing a metal ceramic core in aluminum cladding were tested. The results obtained indicated the feasibility of direct extrusion of fuels containing UO_2 dispersed in Mg. (tr-auth)

7048 PROCESSING NUCLEAR FUELS. Simpson, A. J. Ceram. Age, 83: 50-5(Sept, 1967).

Raw material preparation and fabrication for reactor fuels using mixtures of PuO_2 and UO_2 are reviewed. Denitration of uranyl nitrate hexahydrate and the ammonium diuranate processes are discussed along with history and toxicity of plutonium, mechanical and coprecipitation mixing of U and Pu oxides, the development and production of fuel rods by the pellet-in-tube process and the economic considerations in using PuO_2–UO_2 or UO_2 fuels. (F.S.)

7049 PRACTICAL EXPERIENCE IN THE PRODUCTION OF HIGH-DENSITY COMPONENTS TO ACCURATE DIMENSIONS FROM FINE POWDERS. Martin, F. S. (United Kingdom Atomic Energy Authority, Springfields, Eng.). Powder Met., 10: 221-38(Autumn 1967).

From Symposium on the Role of Powder Metallurgy in Nuclear Technology, London, Nov. 16–17, 1967. See CONF-671108.

The dependence of consistent quality in high-density components on the preparative history of the powder used in fabrication is emphasized, taking uranium dioxide as an example. Consistent dimensions imply consistent densities, microstructures, etc., and the influence of powder quality on these properties is discussed. The chemistry of uranyl nitrate precipitation with ammonia is described with reference to the powder characteristics of the product and the way in which these are modified by subsequent thermal and mechanical treatments, such as hydrogen reduction and micronizing. In the high-throughput production of uranium dioxide solid cylinders for nuclear fuel elements, automatic presses are used; the requirements for granulation and binder addition to ensure a smooth and consistent feed to the presses are considered, together with the precautions necessary

in removal of the binder to avoid subsequent distortion of the pellet on sintering. In the UKAEA, such pellets are made on the ton scale and the typical dimensional spread on as-sintered pellets is ±1% on components of ~0.5 in. dia; the shrinkage of a component on sintering is some 40 vol %. Final sizing, for example, on centerless grinders, reduces the dimensional spread to ±0.0005 in. The experience gained in studying uranium dioxide fabrication is translatable to other special (i.e., nonsilicate) ceramics and to metal powders, as illustrated by work at Springfields on beryllia and alumina. (auth) (UK)

7050 PRODUCTION OF CERMETS CONTAINING A RELATIVELY LARGE AMOUNT OF DISPERSED PHASE. Waldron, M. B. (Univ. of Surrey, Eng.). Powder Met., 10: 288-306 (Autumn 1967).

From Symposium on the Role of Powder Metallurgy in Nuclear Technology, London, Nov. 16–17, 1967. See CONF-671108.

The preparation and properties of dispersions of ceramics in metallic matrices are reviewed, with particular reference to recent British work in this field. There have been substantial advances in the fabrication of cermets by powder metallurgy, particularly those based on UO_2 or PuO_2 and stainless steel, and it is now possible to manufacture almost perfect dispersions in bar or strip form. A closer understanding of the mechanical properties of cermets and porous matrices was achieved. These theoretical and technological developments are capable of wide application to nonnuclear materials. (auth) (UK)

7051 METHOD FOR PRODUCING HIGH MELTING-POINT SPHERICAL CERAMIC PARTICLES. Watanabe, Takaaki (to Mitsubishi Atomic Power Ind., Inc.). Japanese Patent 1966-10339. June 4, 1966. Filed Apr. 22, 1963.

A continuous production high for melting-point large-size spherical ceramic particles is described. It consists of the following steps: high melting-point ceramic powders are mixed to make them into the form of clay, the "clay" is then extruded into the shape of a rod; the rod is heat treated and also pre-heated in the heat treatment furnace; the pre-heated rod is introduced into a plasma torch, where the molten ceramic particles are formed. The molten particles are then solidified and collected. (NSA of Japan)

7052 NUCLEAR FUEL ELEMENT. Hirose, Yasuo (to Hitachi Ltd.). Japanese Patent 1967-3920. Mar. 6, 1967. Filed Nov. 29, 1963.

A method is proposed to maintain the thickness and the density of the layer of vibration-packed fuel powder in the fuel element at constant values, both during the process of fabrication and during the handling after fabrication. This simplifies fabrication and subsequent handling. In the fuel element, the dense vibration-packed fuel powder (layer) is held in position by means of a member, through which gas can pass but the fuel powder cannot, and a plate spring. (NSA of Japan)

7053 BEITRAG ZUR FRAGE DER BINDEFAEHIGKEIT VERSCHIEDENER METALLE MIT NICHTMETALLEN ALS GRUNDBEDINGUNG BEI DER HERSTELLUNG VON CERMETS. (Contribution on the Question of the Binding Capacity of Various Metals with Non Metals for the Production of Cermets). Zagar, Ludvik; Bernhardt, Winfrid. Forschungsberichte des Landes Nordrhein-Westfalen, No. 1733. Cologne and Opladen, Ger., Westdeutscher Verlag, 1966. 91p.

Cermets are materials that consist of metallic and nonmetallic components. The binding between the two components can be of a chemical or physical nature. The conditions for the occurrence of a physical binding between metals and oxidized materials are examined. The concepts of wettability, angle of contact, surface energy, total surface energy, and adhesion energy are defined and explained. Their significance for a physical binding of two components in a cermet system is discussed. The magnitude of the adhesion energy is a measurement for the probability and the strength of a physical binding. From the thermodynamic postulate that a system will be in equilibrium when its free energy had attained a minimum, functional relations between the surface energy of the liquid phase, the angle of contact, and total surface energy between the solid and liquid phases were derived. These expressions lead to a capillary equation, to the cosine θ law, and to the Dupres equation. This relationship offers the best probability for experimental studies by the horizontal drop method. The theoretical principles and the experimental techniques of this method are given. The following systems were investigated: Fe/MgO · Al_2O_3, Co/ZrO_2, Co/SiO_2, Co/Al_2O_3, Co/CaO, Ni/MgO · Al_2O_3, Ni/SiO_2, Ni/CaO, Cu/MgO · Al_2O_3, Cu/ZrO_2, Cu/SiO_2, Cu/Al_2O_3, Ag/MgO · Al_2O_3, Ag/ZrO_2, Ag/SiO_2, Au/MgO · Al_2O_3, Au/ZrO_2, Au/SiO_2, Sn/MgO · Al_2O_3, Sn/ZrO_2, Sn/SiO_2, and Sn/B_4C. The studies were carried out in vacuum and in Ar at temperatures slightly over the melting point of the metallic components. The apparatus arrangement consists essentially of a high frequency heating plant and a quartz glass tube oven. The concentration of the metallic drop was determined by direct measurement using a universal cathetometer. Evaluation of the measurements was made by the Bashfort and Adams method and gave the angle of contact, the density, and the surface energy of the metallic components at the research temperature. The density of the metallic component was used as criteria of the reliability of the measurements. The measured densities of the metals used agree satisfactorily with values from other sources. The surface energy of the metallic component is independent of the angle of contact and the type of substrate. A comparison of the results obtained for the surface energy with literature values revealed good agreement. The adhesion energy of the combinations studied was calculated using the surface energy and the angle of contact. These lie in all cases under 50% of the largest possible value since the angle of contact is larger than 90°. A compilation of data on the angle of contact, surface energy, and adhesion energy from literature is presented. From this compilation it was shown that the adhesion energy in most cases lies under 50% of the maximum value. The oxides were poorly wet by the metals. It was indicated that the state can be improved if the metallic components contain small amounts of other metals. (tr-auth)

7054 METHOD OF FABRICATING CERAMIC NUCLEAR FUEL PRODUCT. Meservey, Albert B.; Sease, J. D.; Fitts, R. B. (to U. S. Atomic Energy Commission). U. S. Patent 3,356,776. Dec. 5, 1967.

Fabrication of thoria ceramic-type fuel rods is described. Powdered thoria is admixed with a weak HNo_3 solution for forming a flocculated, nitrate-stabilized colloidal dispersion, which is then concentrated to provide a sol having a plastic, clay-like consistency. The sol is then extruded into the desired configuration, dried, and then sintered. Pre-sintered and/or lightly calcined thoria powders can be kneaded into the sol prior to the extrusion to reduce sintering shrinkage, eliminate cracking, improve dimensional control, and control the sintered density of the product. (AEC)

Properties Evaluations

Refer also to abstracts 7030, 7035, 7036, and 7069.

7055 (BNWL-296(Pt.2)) ELECTRICAL CONDUCTIVITY OF UO_2. PART II. FINAL REPORT. Bates, J. Lambert (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1967. Contract AT(45-1)-1830. 29p. Dep. CFSTI.

The electrical conductivity of nearly stoichiometric single crystal and polycrystalline UO_2 was measured from room temperature to 3000°K. The electrical conductivity values of polycrystalline UO_2 were the same as the values for single crystal UO_2. The results show no significant difference between the ac (5 to 5000 Hz) and dc conductivity values at all temperatures. The electrical conductivity is intrinsic about 1400°K. The best linear fit of the ln σ versus T^{-1} curve above 1400°K showed. $\sigma = 3.57 \times 10^3\, e^{-1.15\ eV/kt}$. The best fit of the data above 1900°K is obtained with the equation $\sigma = 2.104 \times 10^{-2} T^{1.46} e^{-0.916\ eV/kT}$. (auth)

7056 DEVELOPMENT OF GAS PERMEABILITY IN SINTERED ALUMINA DURING TENSILE CREEP. Fryer, G. M.; Roberts, J. P (Univ. of Leeds, Eng.). pp 299-322 of Science of Ceramics. Vol. 3. Stewart, G. H. (ed.). London, Academic Press, 1967.

From 3rd Conference of the British and Holland Ceramic Society, Bristol, Eng., July 5–8, 1965. See CONF-650729-(Vol.3).

Initially gas-tight tubes of two sintered-alumina materials, one extruded and the other slip-cast, were subjected to axial tensile stresses between 70 and 200 lb $in.^{-2}$ at temperatures between 1450 and 1625°C. Permeability to helium was looked for continuously while creep proceeded, and it was found that the duration of impermeability at a given temperature was highly sensitive to the stress applied. The approximate sizes and numbers of leakage channels formed when the tubes first became permeable were estimated by analysis of the gas-flow kinetics, and in some cases it was possible to check the number of channels by dye impregnation. For a given stress, leakage began at some particular extension regardless of temperature, while as the stress was increased at constant temperature the extension necessary for leakage was greatly reduced. Large numbers of channels of 1 to 4 μm dia developed in both materials, probably through the formation of voids along three-grain boundaries. These small channels were permanent in the case of the extruded material, but with the slip-cast material they could be made to vanish by heating under stress-free conditions at temperatures above about 1400°C. Small numbers of channels of about 10 μm dia also frequently developed in the slip-cast tubes, and these were probably formed when systems of large-diameter pores already present in this material became connected to both wall surfaces. (auth)

7057 KINETICS OF THE REDUCTION OF THE HEXAGONAL MODIFICATION OF URANIUM TRIOXIDE BY METHANE. Semavin, Yu. N.; Vlasov, V. G. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met., No. 4, 121-8(1967). (In Russian).

On the basis of the thermodynamic analysis it was established that the reduction of uranium trioxide with methane at temperatures up to 1000° leads only to the dioxide. The kinetics of the reduction of the hexagonal modification of uranium trioxide with methane (natural gas) at 400 to 600° and pressure of the gas-reducer of 20 to 550 mm Hg were studied. The values of apparent activation energy at different reduction stages were determined. The dependence of the velocity on the methane pressure at constant temperature was established as $V = K p_{CH_4}^{a} \pm 0.05$. The presence of solid solutions in the interval from $\alpha - UO_3$ to U_3O_8 was confirmed. The assumption was made that the limiting stage of the reduction process is the surface reaction between adsorbed products of the decomposition of methane (H and CH) and the oxygen of the oxide. (tr-auth)

7058 DISPERSION-STRENGTHENED ALUMINIUM POWDER PRODUCTS FOR NUCLEAR APPLICATION. Hansen, Niels (Danish Atomic Energy Commission, Riso). Powder Met., 10: 94-115(Autumn 1967).

From Symposium on the Role of Powder Metallurgy in Nuclear Technology, London, Nov. 16-17, 1967. See CONF-671108.

The main properties of sintered aluminium products (SAP) of interest when considering their application in nuclear technology are strength, elongation, corrosion-resistance, homogeneity, purity, compatibility with fuel, and resistance to irradiation damage. These properties are discussed briefly in connection with commercial products. SAP consists of oxide particles finely dispersed in aluminium, normally subdivided into grains. The effect on tensile and creep properties of parameters such as size and volume fraction of the oxide particles, and the grain size of the aluminium, is considered in relation to both commercial and experimental materials. Examination of low-oxide material in the as-extruded and in the recrystallized state shows that the oxide particles are mainly responsible for the high strength and low elongation found SAP at elevated temperatures. The matrix grain size contributes to the tensile strength, in reasonable agreement with the behavior found in pure aluminium, whereas an effect on elongation was not observed. (auth) (UK)

7059 STRUCTURAL AND MECHANICAL PROPERTIES OF SINTERED MAGNESIUM PRODUCTS AT ELEVATED TEMPERATURES. Biais, R. (Societe Trefimetaux, Argenteuil, France); Bitran, M.; Dabosi, F.; Millet, P.; Pegoud, J. Powder Met., 10: 116-44(Autumn 1967).

From Symposium on the Role of Powder Metallurgy in Nuclear Technology, London, Nov. 16-17, 1967. See CONF-671108.

The use of products sintered from pure magnesium or a magnesium alloy is envisaged for certain structural components in nuclear technology. The mechanical properties at elevated temperatures (up to 525°C) of sintered compacts of oxidized Mg-Zr or Mg-MgO of various particle-size ranges (~20 to 800 μ) are discussed. Comparison of the tensile properties and of the values of the creep parameters in tension and compression emphasizes the direct dependence of the increase in mechanical strength at elevated temperatures on the content and distribution of the oxide and on the particle-size distribution of the oxidized powders. Metallographic examination of the various materials confirmed these observations. The ductility varies with the size of the original particles. Data are presented for comparison on a material obtained by sintering Mg-Zr and Mg-Al cuttings. In this case hardening occurs as a result of the formation of intermetallic compounds between the Zr and the Al. (auth)(UK)

7060 MECHANICAL PROPERTIES OF CERMETS WITH A METALLIC MATRIX. McAdam, G. D. (BSA Group Research enter, Birmangham, Eng.). Powder Met., 10: 307-17(Autumn 1967).

From Symposium on the Role of Powder Metallurgy in Nuclear Technology, London, Nov. 16-17, 1967. See CONF-671108.

The effective elastic moduli of cermets consisting of ceramic particles located in a metal are discussed and compared with the properties of sintered matrix materials. Experimental work showed that the properties depend significantly on the degree of bonding between the phases. If this is strong, the nominal Young's modulus increases with concentration; if not (as in uranium oxide-stainless steel) it diminishes, but less rapidly than that of a porous steel. The rigidity modulus falls continuously with the proportion of the ceramic phase present, because local plastic deformation occurs rapidly in shear. The decrease in tensile strength with concentration was previously explained in terms of the packing arrangements of spheres, which reduce the load-bearing area of the matrix cross-section. A tentative expression is derived, which shows that stress concentrations near the inclusions may also play an important role in determining the effective mechanical strength at high ceramic contents. (auth)(UK)

Structure and Phase Studies

7061 (GA-8202) ADVANCED GRAPHITE FUEL SYSTEMS. Quarterly Progress Report for the Period Ending August 14, 1967. Bokros, J. C.; Engle, G. B.; Price, R. J.; White, J. L. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Sept. 8, 1967. Contract AT(04-3)-167. 90p. Dep. CFSTI.

Studies have been conducted on the effects of heat treatment on the mesophase microstructures which develop in extracted carbonized coal-tar pitch. Heat treatments were carried at 450 to 3000°C. Microstructural examination showed cracks starting to form parallel to the mesophase layers at 620°C. The effects of natural graphite flakes or calcined petroleum coke particles on the orientation of mesophase material were examined. The results of separating and identifying the various structural states of carbon and graphite which comprise conventional binder-filler artifacts are presented. The influence of pitch-binder content on the properties and irradiation behavior of molded graphite bodies is described. Studies of the irradiation-induced dimensional changes in natural graphite crystals, annealed pyrolytic carbon, catalytically graphitized carbon, and turbostratic carbon have shown that at irradiation temperatures above 500°C, the changes depend on the crystallite size. The crystallite distortion rates for natural crystals decrease continuously to irradiation temperatures of about 1300°C. Isocronal annealing of a series of irradiated pyrolytic carbons has been carried out at 100°C intervals to 2100°C. The results are presented for dimensional changes, density changes, and changes in electrical conductivity. (D.C.C.)

7062 MICROSTRUCTURE CHANGE INDUCED BY CENTER MELTING AND THE FORMATION OF CENTRAL VOIDS IN POWDER COMPACTED UO_2 FUEL. Kubota, Tadashi; Seki, Yoshinobu; Takahashi, Shuichiro. Nippon Kinzoku Gakkaishi, 31: 406-12(Apr. 1967). (In Japanese).

The microstructure changes induced by center melting and the formation of central voids in powder-compacted UO_2 fuel were studied by center-line heating to obtain information for interpreting the data of in-pile tests done in parallel with this experiment. Single crystalline columnar grains and equiaxed grains were grown in the molten region during the heating process and solidified by the subsequent cooling process, while columnar grains having lenticular voids were grown in the region kept in a solid state throughout the experiment. Both types of columnar grains showed different growth patterns, depending on the changes in the extent of the molten zone. When the molten zone was large, large single-crystal columnar grains were grown in the central region, while small columnar grains having lenticular voids were grown in the region surrounding the large central grains. When the molten zone was small, large columnar grains having lenticular voids were grown in the central region. The central voids were grown not only by melting-down but also by shrinkage of powder compacts associated with sintering when the temperature of the central region was high enough to induce the sintering of UO_2. (Rev. Met. Lit.)

7063 A NEW FAMILY OF OXYGENATED BRONZES OF TUNGSTEN CONTAINING A DIVALENT ELEMENT: THE Ca_xWO_3 SERIES. Vandeven, Daniel; Pouchard, Michel (CNRS, Gironde, France). Compt. Rend., Ser. C, 265: 376-8(Aug. 7, 1967). (In French).

By action of calculated quantities of $CaWO_4$, WO_2, and WO_3 between 400 and 1,000°C, five unpublished phases with the formula Ca_xWO_3 and of the oxygenated bronze type tungsten were detected. The regions of existence determined as a function of temperature and of the proportion of the Ca inserted were defined. An increase in the insertion rate caused an increase in symmetry agreeing with the view of augmentation of temperature but where the first phenomenon is continuous, the second discontinuous. (tr-auth)

7064 STUDY OF ALLOYS BELONGING TO THE ZIRCONIUM-CARBON SYSTEM. Godin, Yu. G.; Evstyukhin, A. I.; Emel'yanov, V. S.; Rusakov, A. A.; Suchkov, I. I. pp 17-22 of High-Purity Metals and Alloys. Fabrication, Properties, and Testing. Emel'yanov, V. S.; Evstyukhin, A. I. New York, Consultants Bureau, 1967.

Zr-C alloys were studied by various methods of physiochemical analysis. Alloys in the cast state and others quenched after annealing were studied metallographically. Microsections of the alloys were prepared for study by grinding with emery paper and polish-

ing with a cloth moistened in a fine suspension of chromium oxide in water. The structure of the alloys was revealed by etching with a mixture of HF and HNO_3. The phase diagram of the Zr–C system is presented. The solidus line was found to consist of 4 parts, which are explained in some detail. A single intermediate phase ZrC, which melts with an open maximum at a temperature near 3500°C was noted. According to the phase diagram, the introduction of C raises the temperature of the $\alpha \rightarrow \beta$ transformation of Zr at the peritectoid composition of 870°C. The solubility of C in the β-Zr was found to be negligibly small, but in α-Zr it reaches a value close to 0.4 wt %. X-ray structural analysis indicates that Zr does not dissolve in C. (B.L.M.)

7065 PHASE DIAGRAM OF THE UC–W SYSTEM AND DIFFUSION OF URANIUM FROM URANIUM CARBIDE INTO TUNGSTEN. Evstyukhin, A. I.; Fedorov, G. B.; Solov'ev, G. I.; Smirnov, E. A.; Zhomov, F. I.; Zaluzhnyi, A. G. pp 79–83 of High-Purity Metals and Alloys. Fabrication, Properties, and Testing. Emel'yanov, V. S.; Evstyukhin, A. I. New York, Consultants Bureau, 1967.

The phase diagram of the UC–W system is presented. The diagram is of the eutectic type with a limited solubility of W in the UC in the solid state. The melting point of the eutectic at 10 wt % W is 2180 ± 20°C. No new chemical compounds are reported. The maximum solubility of W in the samples was found to be ~8 wt % at 2000°C. The solubility of W in the UC was found to be ~4 wt %. The diffusion of W into UC was studied over a temperature range from 1500 to 2100°C. The temperature dependence of the diffusion coefficient may be expressed by $D = 0.11 \exp(-91{,}700/RT)$ cm^2/sec. No interaction between the UC and W over the temperature range studied was reported. (B.L.M.)

7066 IMPURITY EFFECTS AT GRAIN BOUNDARIES IN CERAMICS. Westbrook, J. H. (General Electric Research and Development Center, Schenectady, N. Y.). pp 263–84 of Science of Ceramics. Vol. 3. Stewart, G. H. (ed.). London, Academic Press, 1967.

From 3rd Conference of the British and Holland Ceramic Society, Bristol, Eng., July 5–8, 1965. See CONF-650729–(Vol.3).

Grain boundaries in polycrystalline solids exert a pronounced influence on almost all properties of the materials and affect the kinetics of most solid-state processes that occur therein. An important class of grain-boundary phenomena is composed of steady-state effects caused by differences in composition of the grain-boundary region relative to the overall bulk composition. Although much less studied than in metallic systems, segregation effects in ceramic systems can be expected to be even more powerful and widely prevalent because of the operation of at least three factors: stoichiometric deviation, generally limited solid solubility, and the possibility of electrostatic effects at grain boundaries. Many examples are given of effects of solute segregation on the properties of ceramics on the rate processes which occur therein. The mechanism for solute segregation at grain boundaries was thought to be a form of internal adsorption driven by the possibility of strain relaxation provided by locating solute atoms in disordered grain-boundary regions. It now appears that a much more important mechanism may depend on local trapping of solute when solute-vacancy complexes are decomposed at grain boundaries. The complexes possess sufficient mobility to diffuse from grain interior to the boundary. When decomposition of the complex takes place, however, the vacancy disappears and the unassociated solute, with greatly reduced mobility, is effectively trapped in the boundary region. (auth)

7067 CRYSTAL MODIFICATIONS OF BINARY SYSTEMS CONTAINING MOLTEN ZIRCONIA AND SPRAYED BY ARC PLASMA. Okubo, Tsutomu; Yonemochi, Osamu; Maeda, Minoru; Nakamura, Kazuo Nagoya Kogyo Gijutsu Shikensho Hokoku, 16: 58–65(Feb. 1967). (In Japanese).

Using an arc-plasma flame spraying apparatus, zirconia, natural zircon, the mixture of zirconia and alumina, and the mixture of zirconia and silica (their particle sizes were 74 microns and below) were melted and sprayed on cold metal plates or onto water. The crystal modifications of the specimens were examined mainly by an x-ray method. In the case of highly purified zirconia, the melted specimens were of the monoclinic form only. The tetragonal form of zirconia, which is stable at higher temperature, was not observed. Tetragonal crystals were observed in the specimens of zircon, of the mixture of zirconia and alumina, and of the mixture of zirconia and silica. When heating the film coating the metal plates at 1300°C, most of the crystals transformed themselves from tetragonal to monoclinic zirconia. The content of tetragonal zirconia in the film did not change after exposing it to the air for more than one year. (Rev. Met. Lit.)

7068 ON THE POLYMORPHIC TRANSFORMATION OF ZIRCONIUM DIOXIDE ASSOCIATED WITH THE BREAKAWAY DURING HIGH-TEMPERATURE OXIDATION OF Zr AND SOME Zr ALLOYS. Nakayama, Tadayuki; Koizumi, Tatsuya (Waseda Univ., Tokyo). Nippon Kinzoku Gakkaishi, 31: 839–45(1967). (In Japanese).

The breakaway phenomena of Zr and some Zr alloys during high temperature oxidation were studied by means of high temperature X-ray diffraction, thermal gravimetry, optical microscopy, and differential thermal analysis. The structural change in oxide scale at breakaway is in close relation with the polymorphic transformation of zirconium dioxide (tetragonal ⟷ monoclinic). The continuous observation of change in oxide scales with high temperature x-ray diffraction clarified that black colored pre-breakaway oxide layers contained metastable tetragonal oxide, and that the color change of oxide layers from black to white and the polymorphic transformation to monoclinic oxide occurred simultaneously at breakaway. The contents of tetragonal modification in pre-breakaway oxide scales on Zr alloys containing Ti or Sn were larger than that on pure Zr. This agrees reasonably with the facts that the breakaway occurs at lower temperatures on those alloys, and that those elements lower the transformation temperature of zirconium dioxide. In the stable region of the tetragonal form, the breakaway did not occur in O_2. (auth)

Radiation Effects

Refer also to abstracts 6318, 6338, and 7808.

7069 PHYSICO-CHEMICAL ASPECTS OF URANIUM NITRIDE PRODUCTION. Kostic, Emilija. Nukl. Energ., 4: No. 2, 6–12(1967). (In Slovak).

The use of UC as a reactor fuel element paved the way for the use of other non-oxide materials as nuclear fuels. These materials enable high burnups and higher working temperatures than metallic fuel and better thermal conductivity and greater density of uranium than UO_2. Uranium mononitride has properties better than UC, such as better compatibility with metals and corrosion resistance in air. UN fuel shows better thermal conductivity than UC and UO_2, greater resistance to deformation at high temperatures, and suitable resistance to irradiation during burnup. (auth)

7070 REFRACTORY MATERIALS IN ATOMIC PILES. Elston, J. Tech. Mod., No. 7, 15–22(July 1965). (In French).

Neutron irradiation effects on MgO, Al_2O_3, vitreous SiO_2, and UO_2 were studied and compared with the effects on BeO. (TSS)

7071 THE EFFECT OF PILE-NEUTRON IRRADIATION AND ANNEALING ON THE SWITCHING PROPERTIES OF POINT CONTACT GE-DIODES. Ligenza, Sylwester; Piekoszewski, Jerzy; Przyborski, Wincenty (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 12: 887–90(1967).

In order to lower the switching time of point-contact germanium diodes, the diodes were irradiated in a reactor. The proper irradiation–annealing treatment produces improvement in switching characteristics of diodes due to the reduction of a reverse saturation current. (F.S.)

7072 ELASTIC CONSTANTS OF REACTOR GRAPHITES. Goggin, P. R.; Reynolds, W. N. Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag., 16: 317–30(Aug. 1967).

A complete set of elastic constants was determined for reactor Grade A graphite and also for a nearly isotropic graphite of similar density and crystallite size. The specimens were irradiated in a hollow fuel element in the materials testing reactor BEPO under conditions of good temperature and neutron flux stability at 25°C, and measurements were made periodically until all the elastic moduli had ceased to increase. The experimental values were compared with theoretical values computed from current elastic constant values for single crystals and the anisotropy function describing the distribution of crystallite orientations in a block. The cases of uniform stress and uniform strain were considered, and the role porosity identified. (auth)

Plastics and Other Materials

Refer also to abstracts 6318 and 6933.

7073 (LB/G–2582) RADIATION DAMAGE IN DIAMOND. Nikolaenko, V. A.; Karpukhin, V. I.; Alekseev, S. I. Translated by A. Crozy (Atomic Energy Research Establishment, Harwell, Eng.), from report IAE–1094. 34p. Dep. CFSTI. JCL $3.60 fs, $1.28 mf.

Data are given on the increase of lattice parameter of diamond during annealing. A method is proposed for calculating the activation energy for the annealing of defects, and a spectrum of activation energies was found. On the basis of the results for the change of intensity of x-ray diffraction lines during irradiation, a method was deduced for determining stored energy. Characteristic temperatures for irradiation of diamond were determined. Data concerning diffuse scattering were deduced. (auth)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstracts 7184 and 7658.

7074 STRUCTURE OF POLYTROPES IN MAGNETOSTATIC EQUILIBRIUM. Van der Borght, R. (Monash Univ., Clayton, Australia). Aust. J. Phys., 20: 643-50(Dec. 1967).

The structure of a polytrope is investigated in which a magnetic field, having both poloidal and toroidal components, is present. The influence of the toroidal component on the oblateness of the configuration is also considered. (auth)

7075 ANGULAR VELOCITY DISTRIBUTION IN ROTATING MASSIVE STARS. Legg, M. P. C. (Monash Univ., Clayton, Australia). Aust. J. Phys., 20: 651-62(Dec. 1967).

The angular velocity distribution in rotating massive stars with uniform composition and opacity due to electron scattering is calculated on the assumption that meridional circulation is negligible. The effects of radiation pressure are taken into account in the determination of the differential rotation and the angular velocity is assumed to be independent of latitude. (auth)

7076 ON A GOEDEL-TYPE NONSTATIC COSMOLOGICAL SOLUTION FOR MATTER IN AN ELECTROMAGNETIC FIELD. Raval, H. M. (Gujarat Univ., Ahmedabad, India). Aust. J. Phys., 20: 663-73(Dec. 1967).

Some solutions of the Einstein–Maxwell equations for gravitational and electromagnetic fields against the background of a rotating and either a stationary or an expanding cosmological model were obtained. The details of one of these solutions are given. The solution describes a cosmological model with rotation and shear. The model is initially stationary and then expanding. It is filled with anisotropic fluid and is pervaded by the electromagnetic field, the net charge density being zero. (auth)

7077 SOURCE FLUX DENSITIES AT 153 MHz. Hamilton, P. A.; Haynes, R. F. (Univ. of Tasmania, Hobart). Aust. J. Phys., 20: 697-713(Dec. 1967).

Flux density measurements of 312 sources at 153 MHz obtained from a general continuum survey made with the 210-ft radio telescope of the Australian National Radio Astronomy Observatory, Parkes, N.S.W. are given. The beam width of the telescope at this frequency is 2.18°. Some discussion of results for spectra is given and a comparison is made with other measurements of the same sources. (auth)

7078 RADIO EMISSION FROM CLUSTERS OF GALAXIES. Tovmassian, H. M.; Moiseev, I. G. (CSIRO, Chippendale, New South Wales). Aust. J. Phys., 20: 715-24(Dec. 1967).

From Abell's (1958) list of clusters of galaxies, 137 clusters of distance group 5 were observed at 1410 MHz with the 210-ft radio telescope of the Australian National Radio Astronomy Observatory at Parkes. The detected radio sources were further confirmed by observations at 2650 MHz with the same telescope and at 408 MHz with the east–west arm of the Mills Cross at the Molonglo Radio Astronomical Observatory. A total of 25 radio sources was detected within 5′ arc of the centers of corresponding clusters of galaxies, while the mathematical expectation of the number of random coincidences with clusters is about two or three. The dimensions of most of the radio sources associated with clusters of galaxies are less than 1′ arc, while the dimensions of the clusters are about 25′ arc, which means that, as a rule, a single galaxy of the cluster is responsible for the observed radio emission. There is no correlation between the presence of the radio emission and the richness of the cluster of galaxies. (auth)

7079 OBSERVATIONS OF SOME RADIO SOURCES PREVIOUSLY IDENTIFIED WITH CLUSTERS OF GALAXIES. Tovmassian, H. M.; Moiseev, I. G. (CSIRO, Chippendale, New South Wales). Aust. J. Phys., 20: 725-30(Dec. 1967).

The positions of 33 radio sources previously identified with distant clusters of galaxies were remeasured more accurately to check the identifications. Observations were made at 1410 and 2650 MHz with the 210-ft radio telescope of the Australian National Radio Astronomy Observatory at Parkes, and at 408 MHz with the east–west arm of the Mills Cross at the Molonglo Radio Astronomical Observatory of the University of Sydney. It was found that 21 sources are situated within 5 min of arc of the centers of the corresponding clusters. In three clusters the sources are outside the central area, while five sources are outside the clusters. The remaining four sources were not detected. The dimensions of all sources are much less than the diameters of the corresponding clusters of galaxies, which means that a single galaxy is responsible for the observed radio emission. (auth)

7080 RADIOACTIVITY INDUCED BY COSMIC RADIATION IN THE SAINT SEVERIN METEORITE. Tobailem, J.; David, B.; Nordemann, D. (Centre d'Etudes Nucleaires, Saclay, France. Centre des Faibles Radioactivites, Gif-sur-Yvette, France). pp 207-13 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967. (In French).

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

Low-activity gamma spectrometry measurements (NaI(Tl) scintillator 10 cm × 8 cm) were begun on the 113-kg fragment only 60 hours after it fell, allowing the detection of short-lived radioactive cosmonuclides. The following nuclides were found: ^{24}Na, ^{52}Mn, ^{48}V, ^{56}Co + ^{58}Co, ^{46}Sc, ^{54}Mn, ^{22}Na, ^{60}Co, ^{26}Al, and ^{40}K. (auth)

7081 COSMIC-RAY-PRODUCED ACTIVITIES IN CHONDRITES. Spannagel, G. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Sonntag, C. pp 231-8 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

Cosmic-ray-produced activities in the new carbonaceous chondrite Esebi and in the freshly fallen amphoterite St. Séverin were studied by nondestructive gamma spectroscopy. The total spectrum of the radionuclides was measured. Long-lived ^{40}K and ^{26}Al were the dominant radioactivities detected. The radiation of the β^+ emitters ^{22}Na and ^{26}Al was measured by a $\gamma(511\ keV)-\gamma$ coincidence method. The ^{26}Al specific activity of the St. Séverin meteorite (date of fall: 27 June, 1966) was found to be 0.058 dpm/g. The ^{22}Na specific activity was 0.091 dpm/g. For the carbonaceous meteorite Esebi (date of fall: July 1957) upper limits of <0.08 and <0.01 were derived for ^{26}Al and ^{22}Na, respectively. Spallogenic ^{21}Ne and ^{22}Ne contents of these meteorites were measured by mass spectrometry. From the ^{22}Na activity the ^{26}Al activity, and the rare gas content, exposure ages were derived. The method was calibrated by comparison with the ^{26}Al to ^{21}Ne ratio of other meteorites of well-known age. Radiation ages of 13×10^6 yr for St. Séverin and 1×10^6 yr for Esebi were determined. Histograms of ^{21}Ne–^{26}Al radiation ages for amphoterites and carbonaceous chondrites are discussed. (auth)

7082 COSMIC RADIATION AGES AND SPACE EROSION. II. THE IRON METEORITES. Fisher, D. E. (Univ. of Miami, Fla.). pp 269-80 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

Previously measured ^{36}Ar/^{36}Cl, ^{38}Ar/^{39}Ar, and ^{41}K/^{40}K cosmic radiation ages of eight iron meteorites are compared. In all cases the potassium age is higher, and in four cases the discordancy is beyond the experimental error limits. The discordancy cannot be removed by considerations of argon-diffusion loss, and considerations based solely on a long-term variation of the cosmic-ray intensity are not satisfactory. A time-independent space erosion effect of 2×10^{-8} cm/yr can resolve the discrepancy and bring all the radiation ages into agreement within a conservative error limit of ±10%. (auth)

7083 COSMIC-RAY EXPOSURE AGES AND ORIGIN OF IRON METEORITES. Voshage, H. (Max-Planck-Institut fuer Chemie, Mainz). pp 281-95 of Radioactive Dating and Methods of Low-Level Counting. Vienna, International Atomic Energy Agency, 1967.

From IAEA Symposium on Radioactive Dating and Methods of Low-Level Counting, Monaco, Mar. 2–10, 1967. See STI/PUB-152 and CONF-670309.

Determination of the cosmic-ray exposure ages of iron meteorites by the ^{41}K/^{40}K method has been continued. The ages of more than 60 iron meteorites have been obtained to data. Medium and fine octahedrites of the Ga–Ge group III were essentially produced in two major collisions about 600×10^6 and 700×10^6 yr ago, and fine octahedrites of the Ga–Ge group IVa in one collision about 400×10^6 yr ago. These three events alone supplied about 50% of all iron meteorites. Hexahedrites, coarse octahedrites of the Ga–

Ge group I, and nickel-rich ataxites reveal age distributions which appear to be rather continuous. The differences in the statistics of meteorite production events for different meteorite classes indicate that fundamental dissimilarities may exist in the parent iron masses and parent celestial bodies. Hence, the following models for the origin of iron meteorites have been developed: Rather compact and large nickel–iron masses, perhaps fragments of asteroidal nickel–iron cores, are considered as being the parent masses of fine octahedrites and medium octahedrites of the Ga–Ge groups III and IVa. The meteorites of each group have been produced either when such a nickel–iron mass as a projectile hit another asteroid, or when a comet hit the nickel–iron mass. The hexahedrites, coarse octahedrites of the Ga–Ge group I, and the nickel-rich ataxites are, on the other hand, considered as being fragments of a multiplicity of nickel–iron inclusions ("pools" according to Urey) within the surface layers of Moon, Mars, and asteroids (Mars asteroids), respectively. The fragments, together with stone meteorites, have been produced in a multiplicity of crater-forming impacts by comets on Moon, Mars, or asteroids. (auth)

7084 MOLECULAR HYDROGEN IN PRE-GALACTIC GAS CLOUDS. Saslaw, William C.; Zipoy, David (Cambridge Univ., Eng.). Nature (London), 216: 976-8(Dec. 9, 1967).

It is concluded that during the collapse of pre-galactic gas clouds through a density of about 10^4 particles/cm^3, hydrogen molecules are produced and dominate the subsequent cooling. (auth)

7085 THE DOPPLER EFFECT AS THE CAUSE OF THE SPLITTING IN TYPE-II RADIO-BURST SPECTRA. Fomichev, V. V.; Chertok, I. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 396-402(Nov.-Dec. 1967).

Translated from Astron. Zh., 44: 495-503(May-June 1967).

A discussion is given of the hypothesis interpreting the splitting observed in the dynamical spectra of type-II radio bursts as a Doppler shift occurring when radiating layers having opposite drift velocities of electrons relative to ions are present at the front of a collisionless shock wave. For six bursts, the magnetic-field strength and its height dependence in the corona are estimated from the amount of splitting. This interpretation for the splitting satisfactorily explains the main properties of the fine structure of type-II bursts: the nonmonotonic frequency dependence of the splitting Δf for an individual burst, the increase in Δf with frequency for different bursts, the initial value of Δf, the differing widths and the number of splitting components, the changing relative position of the component bands observed in some bursts, and the time lag of one component relative to the other. (auth)

7086 TURBULENT STRUCTURE AND RADIO EMISSION OF SHOCK WAVES IN RAREFIED PLASMA. Zaitsev, V. V. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.), 11: 392-5(Nov.-Dec. 1967).

Translated from Astron. Zh., 44: 490-4(May-June 1967).

An estimate is obtained for the turbulent width of strong shock waves propagated through a rarefied plasma with a negligible or sufficiently weak external magnetic field. Anomalous dissipation at the shock front results from the excitation of ion-sonic oscillations in the hot electron zone ahead of the front, with subsequent "randomizing" of the ions in the supersonic stream by the oscillations. This process has a considerably smaller linear scale than the width of classical shock waves in isotropic plasma. The brightness temperature of the radio emission produced through scattering of the ion-sonic waves by high-frequency plasma fluctuations is calculated. The expected values are compared with the brightness temperature observed for shock waves traveling through the upper corona and the interplanetary plasma. (auth)

7087 OBSERVATIONS OF TYPE-III SOLAR RADIO BURSTS WITH THE VENUS 2 PROBE. Slyah, V. I. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 389-91(Nov.-Dec. 1967).

Translated from Astron. Zh., 44: 487-9(May-June 1967).

Solar radio bursts were observed at frequencies of 985 kHz and possibly 30 kHz by the Venus 2 space probe. Estimates are obtained for the electron temperature of the outer corona and the velocity of the agent responsible for exciting the radio emission. (auth)

7088 PRELIMINARY COMMUNICATION ON SHORT-TERM OSCILLATIONS OF SOLAR MAGNETIC FIELDS. Severnyi, A. B. (Crimean Astrophysical Observatory, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 383-8(Nov.-Dec. 1967).

Translated from Astron. Zh., 44: 481-6(May-June 1967).

Time variations in solar magnetic fields were recorded simultaneously in two lines, λ5250 and λ6103, on the double magnetograph, aperture size 2.5 × 4.5 in., with the Sun's image held fixed. Sample records are shown. The records, which cover an interval of about an hour, show (a) oscillations with a period of ~7.4 min and amplitude of 10 to 30 gauss in a moderately active region and (b) oscillations with a period of ~9.0 min and amplitude of less than 5 gauss in a quiet region near the center of the disk. The magnetic-field oscillations on the two levels—the difference in height between λ5250 and λ6103 is 260 km—are sometimes synchronous and sometimes phase-shifted. These 7- to 9-min oscillations appear to be interrupted or attenuated occasionally by other lower-amplitude oscillations with a period of ~75 sec. The simultaneous radial-velocity records for both levels at the same time clearly show Leighton's pulsations with a mean period of 297 sec. The simultaneous intensity records show no appreciable oscillations in either line. It is argued that the oscillations observed in the field records cannot be of atmospheric or instrumental origin. (auth)

7089 VARIABLE RADIATION IN A MAGNETODYNAMIC QUASAR MODEL. I. STATISTICAL PROPERTIES OF THE CYCLIC VARIABILITY. Ozernoi, L. M.; Chertoprud, V. E. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 428-41(Nov.-Dec. 1967).

Translated from Astron. Zh., 44: 537-55(May-June 1967).

An analysis is made of the statistical properties of the radiation of a magnetoid, a supermassive star stabilized by regular motion in a magnetic field. A model is considered in which the luminosity fluctuations arise from a periodic (cyclic) circulatory motion analogous to a rotation. Variations in the magnetic field induce periodic changes in the magnetobremsstrahlung flux. The circulatory flow generates a turboconvective flux. The turbulence so influences the large-scale circulatory motion as to generate a randomly varying magnetic-field component and variations in the inclination angle of the lines of force of the magnetoid's regular magnetic field. The fluctuation properties of the magnetobremsstrahlung are investigated in a linear approximation for two limiting cases of the magnetic-field geometry. The results of the model calculations are compared with the statistical properties of the optical radiation of the quasar 3C 273, as derived previously by the authors from photographic observations of the object covering many years. A comparison of theory and observation enables many of the properties of quasars to be explained and some important parameters of the nucleus of 3C 273 to be estimated. The observed cyclic variability of this quasar agrees with the interpretation of the nucleus of a quasi-stellar radio source as a magnetoplasma configuration in a state of quasistable dynamical equilibrium. (auth)

7090 EVOLUTION OF SUPERMASSIVE STARS STABILIZED BY LARGE-SCALE MOTIONS. Bisnovatyi-Kogan, G. S.; Zel'dovich, Ya. B.; Novikov, I. D. Sov. Astron. AJ (Engl. Transl.), 11: 419-27(Nov.-Dec. 1967).

Translated from Astron. Zh., 44: 525-36(May-June 1967).

The evolution of a supermassive star ($M = 10^8$ to $10^9 M_\odot$) stabilized by rotation or turbulence is considered. Two phases of quasistationary evolution are distinguished prior to the loss of hydrodynamic stability by the star. In the first phase the duration of the evolution is determined by the rate of entropy loss. In the second phase the stabilization factor (loss of angular momentum or damping of turbulence) begins to decline and the duration of the evolution is determined both by the decay time and the rate of entropy loss. The first and second general-relativity corrections must be included in determining the point where stability is lost. Arguments are given indicating that stabilization is produced primarily by rotation rather than turbulence. Although turbulence should in fact exist, it will play a secondary part. Rotation will continue to stabilize the star even during outflow of the atmosphere from the equatorial region, with an angular velocity for which no exact stationary solution exists. Thus rotation may play a larger part than previously believed. For the case of a rotating star of mass $M = 10^9 M_\odot$, the maximum duration of the evolution in the first phase is 3×10^3 yr. The evolution in the second phase for a rotationally stabilized star is computed numerically up to the time of collapse, under various assumptions for the momentum loss. The duration of the second phase may reach 3×10^4 yr, which is close to the possible lifetime of quasars. (auth)

7091 CALCULATION OF THE GRAVITATIONAL COLLAPSE OF A SUPERSTAR. Voropinov, A. I.; Zaguskin, V. L.; Podurets, M. A. Sov. Astron. AJ (Engl. Transl.), 11: 442-7 (Nov.-Dec. 1967).

Translated from Astron. Zh., 44: 556-62(May-June 1967).

A procedure is developed for numerical integration of the general-relativity equations of motion, for the case of spherically

symmetric, adiabatic hydrodynamics. The gravitational collapse of a star of mass $M = 2 \times 10^4 M_\odot$ is calculated numerically. The main result is the smoothness of the process in which material converges toward the center. The range of applicability of the adiabatic approximation is estimated. For masses lower than the value considered, nonadiabatic effects, including nuclear reactions and neutrino generation, will become important. (auth)

7092 INTERACTION OF COSMIC RAYS WITH PRIMORDIAL RADIATION. Rozental, I. L. (Inst. of Physical Engineering, Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 448-52(Nov.-Dec. 1967).

Translated from Astron. Zh., 44: 563-9(May-June 1967).

A relation is established between the intensity of the isotropic cosmic x rays, the intensity of metagalactic electrons, and the effective lifetime of the cosmic electrons. The isotropic x rays are assumed to arise through the inverse Compton effect for the cosmic electrons interacting with the primordial radiation discovered recently. A vital aspect of the calculation is an allowance for the expansion of the Universe and the absorption of the x rays (particularly in the range 100 to 1000 eV) as they pass through the metagalaxy. The energy spectra derived for the isotropic x rays would in principle enable a choice to be made between certain hypotheses for their origin (such as the "hot" Universe hypothesis). (auth)

7093 VIBRATIONAL AND KINETIC TEMPERATURES FOR CO MOLECULES IN THE SOLAR PHOTOSPHERE. Sitnik, G. F.; Pande, M. Ch. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 403-9(Nov.-Dec. 1967).

Translated from Astron. Zh., 44: 504-12(May-June 1967).

The vibrational temperature for the solar first-overtone lines of carbon monoxide in the region 2.3 to 2.5 μ is derived from observations made at the center of the solar disk with the Shternberg Astronomical Institute's vertical solar telescope. Sixteen pairs of transitions of the type $[v, J \rightarrow v+2, J']$ and $[v^*, J \rightarrow v^*+2, J']$ in different pairs of combination bands, 0-2, 1-3, 2-4, 3-5, and 4-6, were used for the determination, yielding $T_{vib} = 4800 \pm 250°K$ (rms error). With an acceptable value, $\eta_k = 3.0$ km/sec, for the turbulent velocity in the region where CO molecules exist, the kinetic temperature is found to be $T_{kin} = 4800°K$. A theoretical analysis of rotational and vibrational relaxation shows that (1) in the upper layers of the solar atmosphere T_{kin} has a value close to T_{vib} and T_{rod}; (2) the CO lines in the solar atmosphere are formed by true absorption, not by pure scattering. The present analysis and a previous result $[(T_{rot})_{av} = 4890 \pm 100°K]$ indicate that $T_{kin} = T_{vib} = (T_{rot})_{av} = 4850°K$, within the errors of measurement and the uncertainty in the turbulent velocity. It follows that in the region where the lines of the CO molecule are formed, the condition of local thermodynamic equilibrium is satisfied in the sense of an equilibrium energy distribution over the degrees of freedom of the molecule. The controversy that has arisen from research on lines of neutral and ionized atoms should therefore be resolved in favor of an absence of departures from LTE in the upper photospheric layers. (auth)

7094 PROPAGATION OF HYDROMAGNETIC WAVES IN A SLIGHTLY INHOMOGENEOUS MEDIUM. Getling, A. V. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 410-15(Nov.-Dec. 1967).

Translated from Astron. Zh., 44: 513-20(May-June 1967).

An analysis is made of the propagation of three types of hydromagnetic wave through a nonisentropic medium with a gravity field, in the geometric-optics approximation. The medium is assumed ideally conducting and inviscid. The dispersion equations are established by the small-parameter method individually for different layers of the solar convective zone beneath a sunspot. It is shown that: (1) In this approximation the Alfvén-wave amplitude is constant; (2) if magnetosonic waves differ appreciably in structure from Alfvén waves, they will be damped out for a sufficiently great thermal conductivity; (3) if wave intensification is possible in other cases through convective instability, the coefficient describing it will be bounded above by a quantity whose order of magnitude is determined. (auth)

7095 ANGULAR MEASUREMENTS OF THE STRUCTURE OF 3C 446 AND OTHER QUASARS WITH HIGH REDSHIFTS. Miley, G. K. (Nuffield Radio Astronomy Labs., Cheshire, Eng.); Rickett, B. J.; Gent, H. Nature (London), 216: 974-6(Dec. 9, 1967).

Measurements of the radio source 3C 446 show that it is elongated in the east-west direction and may well be a double source. 3C9 also seems to be a double source. PKS 1116 + 12 and 4C 31.38 have angular dimensions <0.1 and <0.2 sec arc, respectively, in at least one direction. (auth) (UK)

7096 POSSIBLE INTERPRETATION OF THE RADIO EMISSION FROM SMALL COSMIC SOURCES. Kaplan, S. A. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.), 11: 416-18 (Nov.-Dec. 1967).

Translated from Astron. Zh., 44: 521-4(May-June 1967).

Plasma mechanisms for generating coherent radiation are examined in an effort to interpret variable quasars and the local Crab Nebula source. The most efficient mechanism is the interaction of plasma waves with relativistic electrons. (auth)

7097 THE SPECTRUM OF MARS, 1.1 TO 2.5 μ, AT THE 1965 OPPOSITION. Vasil'chenko, N. V.; Moroz, V. I. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 456-61(Nov.-Dec. 1967).

Translated from Astron. Zh., 44: 573-80(May-June 1967).

The infrared spectrum of Mars was recorded in the ranges 1.1 to 1.8 μ with resolution $\Delta\lambda \approx 30$ A, and 1.9 to 2.5 μ with $\Delta\lambda \approx 66$ A. The equivalent widths of the saturated CO_2 bands were measured on the tracings. A comparison with unsaturated bands observed by other authors yields the estimate $p = 23 \pm 12$ mb for the total atmospheric pressure at the surface of Mars. The relative isotopic content $^{18}O/^{16}O$ in the Martian atmosphere agrees, within the errors, with the terrestrial value. (auth)

7098 SPECTROPHOTOMETRY OF AG DRACONIS. Doroshenko, V. T.; Nikolov, N. S. Sov. Astron. AJ (Engl. Transl.), 11: 453-5(Nov.-Dec. 1967).

Translated from Astron. Zh., 44: 570-2(May-June 1967).

Four spectrograms of AG Dra were studied, as obtained in 1961-1962 with a 7° objective prism on the 50-cm Maksutov telescope of the Shternberg Astronomical Institute's Southern Station. The dispersion is 200 A/mm at $H\gamma$. The spectral region 6600 to 3700 A was investigated. The energy distribution in the continuum can be interpreted as the combined radiation of a K3 III star and ionized hydrogen at $T_e = 20{,}000°K$. The intensities of the hydrogen and helium emission lines are variable. The Balmer decrement is discussed. (auth)

7099 RESULTS OF MEASUREMENTS OF LUNAR RADIO EMISSION AT 25.0 AND 30.2 cm. Alekseev, V. A.; Bondar, L. N.; Kamenskaya, S. A.; Krotikov, V. D.; Matveev, Yu. G.; Porfir'ev, V. A.; Strezhneva, K. M. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.), 11: 471-2(Nov.-Dec. 1967).

Translated from Astron. Zh., 44: 593-4(May-June 1967).

The "artificial moon" method was used in making precise measurements of lunar radio emission at 25.0 and 30.2 cm. The mean effective temperature for the lunar disk at these wavelengths was 226 ± 8°K and 277 ± 9°K, respectively. (auth)

7100 RADIO EMISSION OF NORMAL GALAXIES AT 8 cm. Kuril'chik, V. N.; Onishchenko, L. V.; Turevskii, V. M. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.), 11: 528-30(Nov.-Dec. 1967).

Translated from Astron. Zh., 44: 665-7(May-June 1967).

An investigation of the 8-cm radio emission of several normal galaxies is reported. The radio flux and angular size were measured for radio sources in 14 galaxies. (auth)

7101 THE Ly_α/Ly_β INTENSITY RATIO OF THE O VIII ION IN THE SPECTRUM OF THE SOLAR CORONA. Beigman, I. L.; Vainshtein, L. A. Sov. Astron. AJ (Engl. Transl.), 11: 531-2 (Nov.-Dec 1967).

Translated from Astron. Zh., 44: 668-9(May-June 1967).

The intensity ratio of the Ly_α and Ly_β lines of the O VIII ion is calculated as a function of temperature. The two-photon $2s \rightarrow 1s$ transitions are taken into account; under the conditions in the solar corona they materially affect the value of the ratio I_α/I_β. (auth)

7102 ABSOLUTE SPECTRAL ENERGY DISTRIBUTION FOR 14 BRIGHT PLEIADES STARS. Kharitonov, A. V. (Astrophysical Inst., Alma-Ata, USSR). Sov. Astron. AJ (Engl. Transl.), 11: 533-4(Nov.-Dec. 1967).

Translated from Astron. Zh., 44: 669-71(May-June 1967).

The absolute energy distribution was determined for the spectra of 14 bright stars in the Pleiades. The extra-atmospheric monochromatic illuminance of these stars in $erg \cdot cm^{-2} \cdot sec^{-1} \cdot cm^{-1}$ is given. (auth)

7103 FLUX DENSITY OF CASSIOPEIA-A AT 3.0 MHz. Parthasarathy, R. (Univ. of Alaska, College). Science, 158: 1449-50(Dec. 15, 1967).

The flux density of Cassiopeia-A was measured at 3.0 MHz by an interferometer alternately responding to the power in the ordinary and extraordinary modes. The flux indicates attenuation in the path between the source and the solar system by the ionized hydrogen clouds. (auth)

7104 THE UNIQUENESS OF THE INTERPRETATION OF ISOTROPIC COSMIC RADIATION WITH T = 3°K. Zel'dovich, Ya. B.; Novikov, I. D. Sov. Astron. AJ (Engl. Transl.), 11: 526-7 (Nov.-Dec. 1967).

Translated from Astron. Zh., 44: 663-5(May-June 1967).

An analysis is made of the possibility that the cosmic black body radiation having T = 3°K (the "background") might have resulted from a release of energy in celestial bodies at some stage in the cosmological expansion. Such an explanation is shown to be highly unlikely. Some procedures are suggested for observationally confirming the interpretation of the background as primordial radiation in the "hot model." (auth)

7105 AN OBSERVATIONAL STUDY OF THE HYDRODYNAMICS OF THE LOWER SOLAR PHOTOSPHERE. Frazier, E. N. (Univ. of California, Berkeley). Publ. Astron. Soc. Pac., 78: 424-7(Oct. 1966).

An investigation of the connection between the oscillatory small-scale Doppler shifts and continuum granulation which decays exponentially in high-resolution solar spectrograms is described. The investigation was performed by studying the small-scale Doppler shifts and intensity fluctuations of absorption lines that are formed deep in the photosphere. The results of the analysis, applied to the velocity fluctuations, are described. (IAA)

7106 OBSERVATIONS OF QUASI-STELLAR AND HARO-LUYTEN BLUE OBJECTS. Hiltner, W. A.; Cowley, Anne P.; Schild, Rudolph E. (Yerkes Observatory, Williams Bay, Wis.). Publ. Astron. Soc. Pac., 78: 464-70(Oct. 1966).

A description is given of spectrographic observations of quasi-stellar objects and Haro–Luyten blue objects performed in February 1966. Three of the spectrograms obtained are shown. Of the nineteen Haro–Luyten objects selected according to observing convenience, without reference to their colors, only two showed emission lines. An additional sixteen displayed hydrogen absorption spectra. The measured wavelengths of the emission features found in all of the objects, together with the most probable identifications for these emissions and the corresponding redshift computed for each object, are tabulated. (IAA)

7107 MODEL FOR GREAT SOLAR FLARES. Reid, John H. (Sacramento Peak Solar Observatory, Sunspot, N. Mex.). Publ. Astron. Soc. Pac., 78: 454-63(Oct. 1966).

A description of a flare mechanism is given that accounts for many of the observed characteristics of great flares. It also explains why the cosmic-ray flares avoid the years of sunspot minimum while the lower-energy P.C.A. events do not. Six consequences of the model, in addition to the two listed by Elliot (1964), which still require observational evidence, are listed. (IAA)

7108 DETERMINATION OF THE ABUNDANCES OF A STAR RICH IN METALS: τ BOOTIS AND SOME REMARKS ON THE AUUNDANCES OF SOLAR-TYPE STARS. Spite-Lebon, Monique (Observatoire de Paris-Meudon, Hauts-de-Seine, France). Compt. Rend., Ser. A and B, 265: 615-17(Sept. 4, 1967). (In French).

The principal results of the study of the metal-rich star τ Bootis are reported. The correlation between the Fe abundance and the Ca abundance in the atmosphere of solar-type stars was studied on ten stars. (tr-auth)

7109 A SPECTROSCOPIC AND PHOTOMETRIC STUDY OF THE Ap STARS. Wolff, Sidney Carne (Univ. of California, Santa Cruz). Astrophys. J., Suppl. Ser., 15: No. 134, 21-59 (Oct. 1967).

Effective temperatures are derived for a number of Ap and normal A-type stars by comparing observed energy distributions in the interval λλ4000 to 8000 with theoretical models. Surface gravities are derived from measurements of Hγ profiles. It is shown that the temperatures and surface gravities are like those of normal main-sequence stars of spectral types B3–A8. Measurements of line-blocking coefficients are used to correct the observed B–V colors for blanketing. The corrections are found to be small for all but the coolest Ap stars. Corrections to U–B have been derived for five stars, and these corrections are also small. The corrected colors are used to plot the Ap stars in a color-magnitude array and in the two-color diagram. The derived temperatures have been used to estimate the abundances, relative to Fe, of a number of elements which characteristically show abnormal line strengths in Ap stars. The relationship between temperature and kind of peculiarity is discussed. Finally it is shown that there is a correlation between the strength of the Eu II lines, the values of $\langle\eta\rangle$, the average line-blocking coefficient, the Strömgren index m_1, and apparent rotational velocity. The evidence is consistent only with the hypothesis that the Ap stars are slow rotators, not rapid rotators seen pole-on. (auth)

7110 BINARY STARS AMONG CATACLYSMIC VARIABLES. IX. PHOTOELECTRIC OBSERVATIONS OF EX HYDRAE. Mumford, George S. (Tufts Univ., Medford, Mass. Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., Suppl. Ser., 15: No. 133, 1-19(Sept. 1967).

The orbital period of EX Hydrae, a U Geminorum variable that exhibits eclipses, has been found to be $0^d.068233846$. Primary minimum averages 0.6 mag in depth for blue light and lasts less than about 4 min from start to finish. Composite light curves give evidence of a secondary minimum. (auth)

7111 EMISSION OF PARTICLES, CAUSING GEOMAGNETIC STORMS, WITHOUT ACCOMPANYING RADIO EFFECTS. Halenka, Jaroslav (Geofysikalni Ustav, Prague). Geofys. Sb., 13: 395-418(1965).

The relationship between the sudden disappearance of solar filaments and certain exceptional phenomena in the range of solar radio radiation was investigated. It is found that the disappearance of a filament is either not accompanied by any radio effect at all or is accompanied by a radio effect with a chromospheric flare which occurs, as a rule, simultaneously. It is concluded that in a few cases there may be a connection between the disappearance of a filament and very short, usually weak "flares." (IAA)

7112 ESTIMATION OF CERTAIN CHROMOSPHERE PARAMETERS FROM DATA OF RADIO OBSERVATIONS. Yudin, O. I. (Scientific-Research Radiophysics Inst., Gorky, USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 1180-2(1967). (In Russian).

The average "lifetime" of the speculums $\bar{\theta}$ and the average difference in brightness temperatures $\Delta T_{bright} = T_{spec.} - T_{space}$ of the parts of the Sun's surface occupied respectively by the speculum and the interspeculum space can be estimated by using measurements of the correlation function of fluctuations in radioemission from the Sun. A plane model of the Sun is assumed. It is shown that an upper limit to the term $N_\Sigma \Delta T^2_{bright}$ can be established by carrying out measurements at wavelengths of 4 to 6 mm up to 10 cm. Here $\bar{N}_\Sigma$ are the total number of speculums on the solar disk. The largest values of ΔT_{bright} occur in the millimeter-wave range. Fluctuations due to the effect of the troposphere are uncorrelated, and can be eliminated. (TTT)

7113 LONG-PERIOD VARIABLE STARS. Smak, Jozef I. (Univ. of Warsaw). Annu. Rev. Astron. Astrophys., 4: 19-34(1966).

The review is confined primarily to the observational problems, partly because relatively little theoretical work has been done, and partly because it is felt that still more observational data are needed before a successful theoretical treatment of all long-period variables can be undertaken. Attention is restricted to the M-type variables, particularly those of the Mira type. (W.D.M.)

7114 PROBLEMS OF CLOSE BINARY SYSTEMS THAT INVOLVE TRANSFER OF ANGULAR MOMENTUM. Huang, Su-Shu (Northwestern Univ., Evanston, Ill.). Annu. Rev. Astron. Astrophys., 4: 35-56(1966).

A generalized study of the phenomena that take place in close binaries is presented which is based on the principle of angular momentum transfer and dissipation. Only those phenomena that arise directly or indirectly from this consideration are reviewed. (W.D.M.)

7115 ABSOLUTE INTENSITY CALIBRATIONS IN RADIO ASTRONOMY. Findlay, J. W. (Arecibo Ionospheric Observatory, Puerto Rico). Annu. Rev. Astron. Astrophys., 4: 77-94 (1966).

Absolute intensity calibrations of sources of small angular size and known polarization and the radio brightness of extended sky areas are considered. (W.D.M.)

7116 MAGELLANIC CLOUDS. Bok, B. J. (Australian National Univ., Canberra). Annu. Rev. Astron. Astrophys., 4: 95-144(1966).

A review is presented on the Magellanic clouds in terms of distances to the clouds, the brighter stars, the gaseous component (cosmic dust in the clouds), rotation and mass of the clouds, and the evolutionary implications of old and young clusters and associations. (W.D.M.)

7117 STRUCTURE OF RADIO GALAXIES. Moffet, Alan T. (California Inst. of Tech., Pasadena). Annu. Rev. Astron. Astrophys., 4: 145-70(1966).

Techniques of observing the structure of radio galaxies are given and observations are discussed. The types of radio structure are illustrated by descriptions of several of the better-known radio galaxies. (W.D.M.)

7118 EVOLUTION OF PROTOSTARS. Hayashi, Chushiro (Kyoto Univ.). Annu. Rev. Astron. Astrophys., 4: 171-92(1966).

Three chapters are presented which deal with protostars which are not generally in quasi-hydrostatic equilibrium. This is followed by a chapter on quasi-hydrostatic contraction. (W.D.M.)

7119 ASTRONOMICAL MEASUREMENTS IN THE INFRARED. Johnson, Harold L. (Univ. of Arizona, Tucson). Annu. Rev. Astron. Astrophys., 4: 193-206(1966).

A survey of infrared astronomical observations is given and the intrinsic colors, bolometric corrections, and effective temperatures are discussed briefly. (W.D.M.)

7120 HYDROGEN MOLECULES IN ASTRONOMY. Field, G. B.; Somerville, W. B.; Dressler, K. (Princeton Univ., N. J.). Annu. Rev. Astron. Astrophys., 4: 207-44(1966).

Topics discussed include the hydrogen molecules in planetary atmospheres, stellar atmospheres, and interstellar space; rotation–vibration structure of the ground state; electronic structure; fine and hyperfine structure; continuum processes; and scattering of light. (W.D.M.)

7121 POLARIZATION OF COSMIC RADIO WAVES. Gardner, F. F.; Whiteoak, J. B. (Commonwealth Scientific and Industrial Research Organization, Sydney). Annu. Rev. Astron. Astrophys., 4: 245-92(1966).

This review is restricted to linear polarization of the continuum emission from the Galaxy and from discrete sources. It includes a general introduction consisting of the specification of polarization in radio astronomy, a résumé of the relevant synchrotron theories, and an elementary discussion of basic depolarization mechanisms. Experimental techniques are considered and polarization results are reviewed. The relevance of polarization to the structure and evolution of radio sources is discussed. (W.D.M.)

7122 PULSATION THEORY. Christy, R. F. (California Inst. of Tech., Pasadena). Annu. Rev. Astron. Astrophys., 4: 353-92(1966).

This review is concentrated on the question of pulsation in what is known as the Cepheid instability strip in the H–R diagram or in the log g - log T_e diagram. This strip includes the classical δ Cephei variables, the Population II Cepheids, and the RR Lyrae variables. In addition to these, it appears that the RV Tauri variables, δ Scuti variables, and dwarf Cepheids all belong in this same general class. (W.D.M.)

7123 SUPERDENSE STARS. Wheeler, John Archibald (Princeton Univ., N. J.). Annu. Rev. Astron. Astrophys., 4: 393-432(1966).

The gap in the family of equilibrium configurations caused by electron crush is discussed in terms of hydrostatic equilibrium, mass energy for baryons, uniform model, space curvature and elasticity, equilibrium configurations, and the equation of state. The dynamics of collapse and observations of supernovae and superdense stars are considered. (W.D.M.)

7124 SPECTRAL CLASSIFICATION THROUGH PHOTOELECTRIC NARROW-BAND PHOTOMETRY. Stromgren, Bengt (Inst. for Advanced Study, Princton, N. J.). Annu. Rev. Astron. Astrophys., 4: 433-72(1966).

Among the methods of quantitative classification of stellar spectra, classification through photoelectric narrow-band photometry plays an important role. In this review the procedures that have been developed for various parts of the Hertzsprung–Russell diagram are discussed and their advantages and limitations considered in comparison with other methods of classification. (W.D.M.)

7125 PECULIAR VELOCITY OF THE SUN AND ITS RELATION TO THE COSMIC MICROWAVE BACKGROUND. Stewart, J. M.; Sciama, D. W. (Cambridge Univ., Eng.). Nature (London), 216: 748-53(Nov. 25, 1967).

If the microwave blackbody radiation is both cosmological and isotropic, it will only be isotropic to an observer who is at rest in the rest frame of distant matter which last scattered the radiation. An estimate is made of the velocity of the Sun, relative to distant matter, from which a prediction can be made of the anisotropy to be expected in the microwave radiation. (auth) (UK)

7126 CORRELATION BETWEEN SUDDEN COSMIC NOISE ABSORPTION AND SOLAR RADIO BURSTS OBSERVED AT FIVE MICROWAVE FREQUENCIES. Castelli, J. P. (Cambridge Research Labs., Bedford, Mass.); Strauss, F. M. Nature, 216: 776-7(Nov. 25, 1967).

The availability of accurate data at 10.7 cm and other microwave frequencies makes it possible to determine the relative effectiveness of these frequencies as indices of solar–terrestrial interactions. Studies on the correlation of 10.7 cm mean solar flux and 10.7 cm solar radio bursts with sudden cosmic-noise-absorption events have already been described (Basu and Karmakar, J. Geophys. Res. 72: 1901(1967)); the present communication reports the results of a correlation study of solar radio data collected at 606, 1415, 2695, 4995, and 8800 Mc during 1966 and sudden cosmic-noise-absorption data covering the same period. Poor correlation was shown for bursts weaker than 15 flux units. Considering only bursts with peak flux densities >15 units, it was found that correlation increased with frequency, being about twice as good at 8,800 Mc as at 606 Mc. About half of all radio burst spectra showed a positive gradient (the flux increased towards the higher frequencies). (UK)

7127 SPECTRUM OF THE 3°K COSMIC MICROWAVE RADIATION. Howell, T. F.; Shakeshaft, J. R. (Cambridge Univ., Eng.). Nature (London), 216: 753-4(Nov. 25, 1967).

Measurements of the 3°K cosmic blackbody radiation at frequencies below about 1 GHz have a limited accuracy because radiation from the Galaxy becomes a dominant component. Measurements at 408 and 610 MHz nevertheless show that there is a radiation component at these frequencies which is consistent with a blackbody spectrum of about 3°K. (auth) (UK)

7128 T TAURI STARS. McNally, D. (London Univ.). Sci. Progr. (London), 55: 305-11(Summer 1967).

Some of the properties of T Tauri stars are discussed in relation to pre-main sequence stellar evolution. (auth) (UK)

7129 PRE-MAIN-SEQUENCE EVOLUTION. Williams, I. P.; Cremin, A. W. (Univ. of Reading, Eng.). Nature (London), 216: 878-80(Dec. 2, 1967).

Reference is made to the work of Hayashi and others in this field. It is stated that whilst Hayashi's model (Pub. Astron. Soc. Japan 13: 450(1961)) apparently gives an essentially correct description of stellar evolution before the main sequence, by its very nature it cannot represent the evolution by a simple set of equations, and fresh calculations have to be performed for each stellar mass, which is particularly inconvenient in regard to stellar clusters. The present authors propose an approximation which can be represented by simple equations, and in which there are no major differences in results as compared with Hayashi's more complex model. (UK)

7130 RE-EXAMINATION OF THE SOURCE COUNTS FOR THE 3C REVISED CATALOGUE. Jauncey, D. L. (Cornell Univ., Ithaca, N. Y.). Nature (London), 216: 877-8(Dec. 2, 1967).

Because of the importance attached by cosmologists to the number-flux curves for various classes of radio sources, a re-examination of the data from the optical identifications of the 3C Revised Catalogue was undertaken. The reason for the re-examination was the possible inapplicability of the curve fitting methods adopted in earlier compilations, as regards statistical dependence. In order to derive a reliable estimate of the exponent in the number-flux curve it appeared preferable to fit the differential spectrum rather than the integral spectrum to the experimental results, and adopt the method of maximum likelihood estimation rather than the least squares estimate. Results are tabulated and compared with previous results; the re-calculated exponents differed somewhat from the earlier values, and the influence on data interpretation is discussed. It is concluded that no definite interpretation regarding the cosmological significance of the difference between exponents can be drawn from the present 3C Revised Catalogue. (UK)

Atomic and Molecular Physics

Refer also to abstracts 6682, 7444, 7461, 7465, 7564, and 7710.

7131 (JINR–P9-3589) ISSLEDOVANIE IONIZATSII POLYARIZOVANNYKH ATOMOV VODORODA V RAZRYADE PENNINGA. (Investigation of Ionization of H Polarized Atoms in the Penning Discharge). Plis, Yu. A.; Soroko, L. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 8p. (In Russian). Dep.

The results of investigation of polarized atoms ionization in an apparatus with the Penning discharge are given. The ionization efficiency turned out to be proportional to the anode length. At the anode length equal to 36 mm the ionization efficiency is equal to $(0.7 \pm 0.15)10^{-3}$, and at the length of 130 mm it is equal to $(2.7 \pm 0.6)10^{-3}$. The experimental results are compared with the data published. (auth)

7132 (ORNL–4168, pp 119-82) RADIATION PHYSICS. Hurst, G. S. (Oak Ridge National Lab., Tenn.).

Summaries of studies in each of the following areas are given: (1) theoretical radiation physics, (2) interaction of radiation with solids and liquids, (3) atomic and molecular radiation physics, and (4) physics of tissue damage. (M.O.W.)

7133 THE IONIZATION OF Ar ATOMS TO AN EXCITED STATE OF Ar^+. Vainshtein, L. A.; Vinogradov, A. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 101-2(Aug. 1967).

Translated from Opt. Spektrosk., 23: 185-7(Aug. 1967).

The cross sections for the ionization of Ar atoms by electrons to the ground and excited states of the Ar^+ ion are calculated in the first Born approximation. The cross section for ionization to

an excited state is 200 times smaller than the cross section for ordinary ionization. (auth)

7134 PHOTODISSOCIATION OF THE MOLECULAR HYDROGEN ION. Oksyuk, Yu. D. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 115-18(Aug. 1967).

Translated from Opt. Spektrosk., 23: 213-19(Aug. 1967).

The cross sections for the photodissociation of the ionized hydrogen molecule are calculated in the wavelength range from 1000 to 10,000 Å. The results of the calculations are compared with the experimental data, and possible causes for the discrepancy between theory and experiment are discussed. Ways of eliminating this discrepancy are indicated. (auth)

7135 POSSIBILITIES FOR MEASURING WEAK MAGNETIC FIELDS BY METHODS OF OPTICAL ORIENTATION OF ATOMS. Aleksandrov, E. B.; Bonch-Bruevich, A. M.; Khodovoi, V. A. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 151-4(Aug. 1967).

Translated from Opt. Spektrosk., 23: 282-6(Aug. 1967).

The possibilities of measuring weak magnetic fields by methods of optical orientation of atoms are discussed. A new method of measuring extremely weak magnetic fields, based on the comparison of the efficacy with which light and magnetic fields act on the atomic system, is considered. A theoretical analysis shows that the optimal objects are alkali-metal atoms, and the optimal mode is that of extremely low intensities of the orienting light. It is shown that when the object and the optical-orientation regime are optimally chosen, the proposed method guarantees a maximum sensitivity not worse than 10^{-11} Oe at a recording-equipment bandwidth of 1 Hz. (auth)

7136 QUADRATIC STARK EFFECT CONSTANTS. Kluge, K.; Kerniei, I.; Petkov, A. P.; Verosh, T. (Univ. of Technical Sciences, Budapest. Sofia Univ.). Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 181-2(Aug. 1967).

Translated from Opt. Spektrosk., 23: 334-8(Aug. 1967).

Following Unsöld's quantum-mechanical calculations, 39 quadratic Stark effect constants are computed for 8 elements. The results are discussed. (M.H.R.)

7137 IONIZATION OF THE HELIUM ATOM BY ELECTRON IMPACT. Pecul, K. (Inst. of Nuclear Research, Warsaw. Univ. of Warsaw). Acta Phys. Pol., 32: 605-9(1967).

Cross sections for the ionization of the helium atom by electron impact are calculated in the Born approximation, using several sets of parameters in the wave function for the initial and final state. Some errors in the results published by other authors are corrected. The dependence of the calculated cross section on the choice of wave functions is discussed. (auth)

7138 BOUNDS FOR van der WAALS COEFFICIENTS FROM PADE APPROXIMANTS. Langhoff, P. W.; Karplus, M. (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett., 19: 1461-3 (Dec. 25, 1967).

A method utilizing Padé approximants for determining upper and lower bounds to van der Waals coefficients from theoretical and/or experimental values of the dynamic polarizability is reported. Application was made to hydrogen and the rare gases. (W.D.M.)

7139 EXPONENTIAL APPROXIMATION FOR TRANSITION PROBABILITY. Mori, Masatake (Tokyo Univ.). J. Phys. Soc. Jap., 23: 1086-93(Nov. 1967).

An approximate solution of the time-dependent Schrödinger's equation in the form of the exponential representation is discussed. A method is proposed for making calculations feasible in the exponential representation by means of diagonalization of the time-dependent matrix. The method is applied to a problem of transition involving a continuous state. A set of orthogonal functions is proposed with which the unitary transformation matrix that diagonalizes the continuous matrix in question can be constructed. A formula for the transition probability of predissociation or autoionization is obtained. The error estimation for the approximate values and a rough criterion for the validity of the exponential representation are given. (auth)

7140 RADIATION BY A BEAM OF ELECTRONS PASSING CLOSE TO A DIFFRACTION GRATING. Fox, A. J.; Schofield, J. M. S. (Mullard Research Labs., Surrey, Eng.). pp 140-5 of Microwave and Optical Generation Amplification. IEE Conference Publication 27. London, The Institution of Electrical Engineers, 1967.

From 6th International Conference on Microwave, Optical Generation, and Amplification, Cambridge, Eng., Sept. 12-16, 1966. See CONF-660932.

An experiment was performed using a strip electron beam one inch wide by a hundred microns deep of energy up to 130 keV ($\beta = 0.6$) and a useful current density of ~1 mA/cm^2. The grating was one inch square and of the echellette type with $N = 3 \times 10^4$ ruling. The experimental results along with new theories are described. (M.O.W.)

7141 METHOD FOR THE PRODUCTION OF GAMMA QUANTA BY COMPTON EFFECT ON RELATIVISTIC ELECTRONS. Kulikov, O. F.; Tel'nov, Yu. Ya.; Filippov, E. I.; Yakimenko, M. N. (Inst. of Physics, Moscow). Prib. Tekh. Eksp., No. 4, 14-19(July-Aug. 1967). (In Russian).

A method for the realization of the counter collision of an electron beam, accelerated in the synchrotron, with a beam of laser photons is reported. The efficiency of the method is confirmed by the results of the investigation of the spectral angular distribution of γ quanta, obtained as a result of the Compton effect on relativistic electrons. (tr-auth)

7142 MULTICHANNEL SHAPER FOR MOLECULAR BEAMS. Meshcheryakov, N. A.; Perfil'ev, B. V.; Gabe, D. R.; Trubetskoi, A. I. (Inst. of Mathematics, Novosibirsk, USSR). Prib. Tekh. Eksp., No. 4, 212-14(July-Aug. 1967). (In Russian).

A multichannel shaper for molecular beams with intensity from 10^{13} to 10^{15} molecules/cm^2 sec is described. The shaper was experimentally tested on molecular beams of hydrogen and oxygen. The measurements showed a small fluctuation of the molecular density in the beam. (tr-auth)

7143 EFFECTS OF THERMAL ENERGY AND ION-REMOVAL TIME ON THE "PULSED SOURCE" METHOD FOR MASS SPECTROMETER INVESTIGATIONS OF ION–MOLECULE REACTIONS. Challinor, R. A.; Duncan, R. A. (CSIRO, Camden, New South Wales). Aust. J. Phys., 20: 633-42(Dec. 1967).

Two aspects of an experimental technique designed to investigate the dependence of ion–molecule specific reaction rates on primary ion energy are examined. In this experiment the reaction proceeds in a mass spectrometer ion source under a constant electric field, and the ratio of secondary to primary ions is recorded as a function of time. Two assumptions lay behind the original treatment, namely that the energy spread of the primary ions at a given time was small, and that reactions taking place during the application of an ion-removal field were negligible. The present paper takes an idealized view of the ion source by ignoring possible effects of nonuniform electric fields and extraneous magnetic fields. Calculations are made which show that both ion-removal time and thermal energy are important. The initial thermal velocity and the electric field in the ion source interact to produce a large energy spread. For energy-independent reactions, a simple correction of experimental results should give true specific reaction rates. (auth)

7144 STABILITY OF A ROTATING RING OF DISCRETE CHARGES IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Heath, Gregory E. (Stanford Univ., Calif.). J. Appl. Phys., 38: 5306-12(Dec. 1967).

Experimental results indicate that certain configurations of discrete charges may be more stable than continuous distributions possessing the same charge and corresponding symmetries. A model of N identical infinitely long negatively charged rods rotating under the influence of a uniform applied magnetic field is here investigated for stability of perturbations about an equilibrium configuration and compared to a continuous charged sheet. For the continuous sheet, a countably infinite number of modes of oscillation are possible of which only a finite number may be stable. The finite number of stable modes are those corresponding to the longer wavelengths and the growth rates of the infinite number of unstable modes increase as the wavelength decreases. In constrast, the discrete distribution may support only 2N-3 modes of oscillation. The first modes to become unstable when critical parameters are adjusted are those corresponding to the shortest wavelengths. These also have the highest growth rates. The most significant result of this investigation is that the discrete distribution may have all vibrational modes stable while this is impossible for the continuous distribution. Application of the discrete-charge theory to explain the stability of experimentally observed vortex patterns in unneutralized electron beams is also discussed. (auth)

7145 ELECTROMAGNETIC FORCES IN CONDUCTORS. Dodd, C. V.; Deeds, W. E. (Oak Ridge National Lab., Tenn.). J. Appl. Phys., 38: 5045-51(Dec. 1967).

Relaxation-averaging formulas are derived for magnetic-induction problems involving axially symmetric fields with sinusoidal or pulsed time dependence in media which may be linear or nonlinear, homogeneous or inhomogeneous. Solutions have been obtained from a high-speed digital computer for time-harmonic fields in linear, inhomogeneous media. From these solutions, the electromagnetic forces are calculated and compared with experimental measurements. It is found that the computed and measured values agree quite well and that most of the dis-

crepancy can be explained by the fact that the permeability of the ferrite used in the measurements was different from that assumed in the calculations. (auth)

7146 SPOT DISTORTION CAUSED BY MAGNETIC DEFLECTION OF AN ELECTRON BEAM. Wang, C. C. T. (IBM Watson Research Center, Yorktown Heights, N. Y.). J. Appl. Phys., 38: 4938-44(Dec. 1967).

When a focused electron beam is deflected by a transverse magnetic field through a small angle, the spot shape on the target is distorted. The electron density distribution within it also varies. A novel method of calculating and presenting the characteristics of the distorted spot is presented. The positions of the electrons at the incoming aperture are mapped into the target plane subsequent to the deflection. The resultant density distribution is plotted by the computer. (auth)

7147 SIMPLIFIED ANALYSIS OF POINT-CATHODE ELECTRON SOURCES. Everhart, T. E. (Univ., Tuebingen, Ger.). J. Appl. Phys., 38: 4944-57(Dec. 1967).

The accelerating field of a point-cathode electron source is divided into two regions, a diverging spherical-field region located in the immediate vicinity of the point cathode, and a converging-field region which occupies most of the cathode–anode space. Analysis of this model gives the Gaussian source size, axial position of the source, and spherical- and chromatic-aberration constants of the pointed-cathode electron gun. After including diffraction effects, the electron-optical parameters are optimized for minimum possible source size. The current density which appears to be emitted by the apparent source is introduced as a figure of merit for this type of electron gun, and the performance of field-emission and Schottky-emission pointed cathodes are compared. Source diameters below 100 Å are predicted for oriented-tungsten field-emission pointed cathodes, with apparent current densities exceeding 10^4 A/cm^2; source diameters below 1000 Å are predicted for oriented-tungsten Schottky-emission pointed cathodes, with apparent current densities of approximately 100 A/cm^2. (auth)

7148 THERMAL CONDUCTIVITIES OF THE GAS MIXTURES D_2–He, D_2–Ne, AND D_2–He–Ne. Gandhi, J. M.; Saxena, S. C. (Rajasthan Univ., Jaipur, India). Brit. J. Appl. Phys., 18: 807-12(June 1967).

Employing the well-known method of the thick-wire variant of the hot-wire cell, thermal conductivity values for the gas mixtures D_2–He, D_2–Ne and D_2–He–Ne were measured as a function of their composition at temperatures of 30, 50, 70, and 90°C. The experimental results are interpreted by the theory of Hirschfelder and its approximate version as given by Mason and Saxena. The study leads to some interesting and useful conclusions. (auth) (UK)

7149 SELF-ABSORPTION EFFECTS IN THE SOFT X-RAY M_α AND M_β EMISSION SPECTRA OF THE RARE EARTH ELEMENTS. Fischer, David W.; Baun, William L. (Air Force Materials Lab., Wright-Patterson AFB, Ohio). J. Appl. Phys., 38: 4830-6(Nov. 1967).

The M_α and M_β emission spectra and the M(IV) and M(V) absorption spectra have been studied for the rare earth elements. It is conclusively shown that the complicated multiplet structure observed in the emission spectra is not real emission structure but is, instead, produced by sample self-absorption. This is demonstrated by observing the emission spectra over wide variations in take-off angle and bombarding-electron energies and finally by comparing the detailed structure of both the emission and absorption spectra. The M(IV) and M(V) absorption structure completely overlaps the M_α and M_β emission lines which are each found to have but one intensity maximum when obtained under conditions of minimum self-absorption. Some of these spectra have never been shown previously, while others have been studied in detail by several investigators. Points of agreement and disagreement with previous work are mentioned and the wavelengths of the emission lines and absorption edges are listed for all of the lanthanides. It is concluded that 4f → 3d electron transitions are reversible in these elements. (auth)

7150 PLASMA–METAL CONTACT: ENERGY SPECTRUM OF EMITTED SECONDARY ELECTRONS. Martinov, N.; Stainov, G. (Sofia Univ. Inst. of Physics, Bulgarian Academy of Sciences, Sofia). Compt. Rend. Acad. Bulg. Sci., 20: 779-82 (1967).

A brief theoretical analysis of the electron energy spectra is given. (M.O.W.)

7151 POLARIZATION OF THE 3^1P–2^1S TRANSITION OF HELIUM EXCITED BY PROTON IMPACT. Scharmann, A.; Schartner, K. H. (Univ., Giessen, Ger.). Phys. Lett., 26A: 51-2(Dec. 4, 1967).

The polarization fraction of the 3^1P–2^1S (5016 Å) transition of helium excited by proton impact in the energy range of 100 keV to 1000 keV was measured and compared with experimental results in the range of 1 to 150 keV, electron impact measurements, and theoretical calculations. (auth)

7152 POLARIZATION OF LYMAN-ALPHA RADIATION PRODUCED IN COLLISIONS OF ELECTRONS AND HYDROGEN ATOMS. Ott, W. R.; Kauppila, W. E.; Fite, W. L. (Univ. of Pittsburgh). Phys. Rev. Lett., 19: 1361-3(Dec. 11, 1967).

The polarization of Lyman-alpha radiation emitted when electrons excite free hydrogen atoms was studied in a modulated crossed-beam experiment, in which the polarization was measured directly using a Brewster's-angle reflection analyzer. The measured polarization fraction as a function of electron energy to 250 eV and two theoretical predictions are shown. The experimental results over the energy range 10 to 14 eV are also shown. (M.H.R.)

7153 ATOMIC DIFFERENTIAL SPIN-EXCHANGE SCATTERING. Pritchard, David E.; Burnham, David C.; Kleppner, Daniel (Massachusetts Inst. of Tech., Cambridge). Contract DA 28-043-AMC-02536(E). Phys. Rev. Lett., 19: 1363-6 (Dec. 11, 1967).

Differential spin-exchange scattering of sodium from cesium has been observed by the crossed-atomic-beam scattering technique. The angular dependence of the exchange probability yields details of the singlet-triplet potential differences, including the depth and position of the triplet potential minimum. Results are also reported for potassium scattering from molecular oxygen. (auth)

7154 ELASTIC DIFFERENTIAL SPIN-EXCHANGE CROSS SECTIONS FOR SCATTERING OF SLOW ELECTRONS BY POTASSIUM. Collins, Richard E.; Goldstein, Marvin; Bederson, Benjamin; Rubin, Kenneth (New York Univ., N. Y.). Phys. Rev. Lett., 19: 1366-8(Dec. 11, 1967).

The differential spin-exchange cross section $\sigma_{ex}(\theta)$ was measured relative to the differential cross section $\sigma(\theta)$ for the scattering of 0.5-eV electrons by potassium, for angles between 10 and 180° in the electron polar scattering angle. The ratio $\sigma_{ex}(\theta)/\sigma(\theta)$ increases monotonically from approximately 0 at 10° to 0.7 ± 0.1 at 180°. (auth)

7155 BRANCHING RATIO OF PARA- AND ORTHO-HELIUM IN THE ELECTRON IMPACT EXCITATION FROM THE GROUND SINGLET STATE. Kang, Ik-ju (Southern Illinois Univ., Carbondale). Phys. Lett., 26A: 25-6(Dec. 4, 1967).

The ratios of differential and total cross sections for electron-impact excitation of singlet- and triplet-states helium atoms from the ground state are studied both in the threshold and in the high energy regions. (auth)

7156 THE LUMINESCENCE OF GASEOUS RADIOACTIVE KRYPTON DUE TO ATOMIC REARRANGEMENT AND INELASTIC COLLISIONS WITH SHAKE-OFF ELECTRONS. Parsche, H.; Luchner, K. (Technische Hochschule, Munich). Phys. Lett., 26A: 9-10(Dec. 4, 1967).

The luminescence of radioactive Kr is shown to contain a component emitted by the decayed atom as a consequence of rearrangement processes; its spectral distribution is characteristic for the single ionized daughter atom. The background luminescence indicates the presence of mostly very slow shake-off electrons. (auth)

7157 APPROXIMATE ANALYTICAL WAVE FUNCTIONS FOR Pr^{3+}. Synek, M. (Texas Christian Univ., Fort Worth); Corsiglia, L. Contract F33615-67-C1438. Phys. Lett., 26A: 19-20(Dec. 4, 1967).

Approximate analytical self-consistent field wave functions were calculated for Pr^{3+}. For the purpose of this work the minimum and the saturated basis set approximations were combined. All the orbital exponents were optimized. (auth)

7158 ELECTRON SCATTERING BY NEUTRAL ALKALIES AT THE FIRST THRESHOLD OF EXCITATION. Salmona, A. (Observatoire de Paris). J. Phys. (Paris), 28: 776-82(Oct. 1967). (In French).

A method is given to calculate the collision cross-sections when the incident electrons have precisely the energy necessary to excite the atom from the ground state to the first excited level. The method can also be applied to the case of zero electron energy. Furthermore it is possible to evaluate numerically the behavior of certain partial cross sections in the neighborhood of the first excitation threshold. (auth)

7159 ACCELERATION OF IONS IN ELECTRON BEAMS. Plyutto, A. A.; Belensov, P. E.; Korop, E. D.; Mkheidze, G. P.; Ryzhkov, V. N.; Suladze, K. V.; Temchin, S. M. JETP Lett. (USSR) (Engl. Transl.), 6: 61-5(Aug. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 540-41(Aug. 1, 1967).

Experiments were conducted on a vacuum-spark plasma. Mass spectrograms are given of the ion acceleration in electron beams. (M.O.W.)

7160 CRYSTAL-FIELD SPLITTING OF ORTHOHYDROGEN IN SOLID PARAHYDROGEN. Hardy, Walter N. (North American Rockwell Corp., Thousand Oaks, Calif.); Gaines, James R. Phys. Rev. Lett., 19: 1417-20(Dec. 18, 1967).

From NMR measurements the crystal-field splitting of an ortho-H_2 molecule in solid para-H_2 was estimated to be 8.2×10^{-3} °K. This lowers the existing upper limit on the splitting by a factor of 5. (auth)

7161 DIRECT DEMONSTRATION OF THE VALIDITY OF THE WIGNER SPIN RULE FOR HELIUM–HELIUM COLLISIONS. Abrams, R. L.; Wolga, G. J. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 19: 1411-14(Dec. 18, 1967).

There has been considerable discussion in the past thirty years about the validity of the Wigner spin rule for the collision process: $He(n^1P) + He(1^1S_0) \rightarrow He(n^3D) + He(1^1S_0) \pm E_k$. In the experiment reported here, it is shown directly that processes such as that shown in the equation are improbable. This is the first direct demonstration of the validity of the Wigner spin rule for He. Lin and Fowler's prediction is confirmed by demonstrating that similar processes involving the 4^3F state occur almost as readily as those processes involving no spin change. (W.D.M.)

7162 CHARGE EXCHANGE FOR H^+ TO H^- IN POTASSIUM OR CESIUM VAPOR IN THE ENERGY RANGE 0.5 TO 2 keV. Bohlen, H.; Clausnitzer, G.; Wilsch, H. (Univ., Erlangen-Nuermberg). Z. Phys., 208: 159-64(1968). (In German).

For sources for polarized ions at a tandem accelerator the charge-changing process from H^+ to H^- in potassium and cesium metallic vapor is very favorable. The charge-changing yield in potassium amounts to 10% at a proton energy of 0.5 to 1.5 keV, and to 15% in cesium at a proton energy of 0.5 keV. (auth)

7163 ENERGY LOSS OF OXYGEN AND SULPHUR IONS IN MATTER. Armitage, B. H.; Hooton, B. W. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Instrum. Methods, 58: 29-38(Jan. 1968).

The differential energy loss of ^{16}O ions in Au and Ag in the energy range 10 to 30 MeV and the differential energy loss of ^{32}S in Au from 19 to 40 MeV have been measured to an accuracy of ±4%. Good agreement has been obtained with similar measurements with ^{16}O ions by Booth and Grant. Equilibrium charge distribution measurements have been carried out, and discrepancies have been observed between the root mean square charge and the effective charge. Autoionization is discussed as one of the possible causes of this discrepancy. (auth)

7164 SURFACE PHENOMENA. pp 29-71 of Eighth International Conference on Phenomena in Ionized Gases, Vienna, Austria, August 27–September 2, 1967. Vienna, Springer-Verlag, 1967.

See CONF-670810.

Forty-three papers are included on the following subjects: (1) secondary particles (ions and neutrals), (2) secondary particles (electrons), (3) sputtering and radiation damage, (4) scattering and quantum effects, (5) laser-induced emission, (6) gas release phenomena, and (7) work function and field emission. (M.O.W.)

7165 ION AND PLASMA SOURCES. pp 535-54 of Eighth International Conference on Phenomena in Ionized Gases, Vienna, Austria, August 27–September 2, 1967. Vienna, Springer-Verlag, 1967.

See CONF-670810.

Twenty papers are included on the following subjects: (1) ion sources, (2) plasma jets, and (3) various plasma sources. (M.O.W.)

7166 DETERMINATION OF THE PENETRATION COEFFICIENT OF FAST H^+ IONS IN METALS BY THE CONDENSATION METHOD. Borovik, E. S.; Katrich, N. P.; Nikolaev, G. T. At. Energ. (USSR), 23: 102-5(Aug. 1967). (In Russian).

Results of the measurement of the penetration coefficient of H^+ ions with energy of 35 keV in Ni and Ti, obtained by the method of the condensation of nonpenetrating hydrogen, are reported. During the condensation atomic hydrogen recombines, eliminating the necessity of measuring the partial pressure of atomic hydrogen. At temperatures of 78, 300, and 1000°K, the penetration coefficient in the region of comparatively high concentration of penetrated hydrogen is 0.5, 0.3, and 0.06 for Ni and 0.5, 0.9, and 0.1 for Ti. These results agree well with earlier results and indicate that the diffusion and mechanism of diffusion of the hydrogen in atomic form does not determine the size of the coefficient. (tr-auth)

7167 MUONIUM. Hughes, W. Phys. Today, 20: No. 12, 29-40(Dec. 1967).

A basic review of the literature on muonium is given. (M.O.W.)

7168 EXCITATION OF THE 4F STATES OF HELIUM. Jobe, John D.; St. John, Robert M. (Univ. of Oklahoma, Norman). J. Opt. Soc. Amer., 57: 1449-51(Dec. 1967).

Recent studies of the population processes of the 4F state in helium by observation of the infrared radiation from this state have given direct experimental evidence for the 4^1P to 4F excitation-transfer process. The behavior of the apparent cross sections of the 4^1P and 4F states with pressure is used to evaluate the cross section for the excitation transfer and the cross section for electronic excitation to the 4F state. Analysis of the data indicates a cross section of 1.5×10^{-14} cm^2 for the 4^1P to 4F transfer and 1.6×10^{-19} cm^2 at 100 eV for the electron excitation plus cascade of the 4F state. Apparent cross sections of the 4F state are presented at high and low pressure from onset to 450 eV. At high pressure the apparent cross section is similar to that of the 4^1P state. As the pressure is lowered, the shape of the excitation function approaches that of a ^1D state. (auth)

7169 CLASSICAL DERIVATION OF THE MAGNETIC HYPERFINE ANOMALY. Sorensen, Raymond A. (Carnegie-Mellon Univ., Pittsburgh). Amer. J. Phys., 35: 1078-81(Nov. 1967).

It is shown that all the qualitative effects of magnetic hyperfine interaction can be obtained nonrelativistically. (auth)

7170 CALCULATION OF THE IONIZATION CROSS SECTIONS OF ATOMS BY HIGH-ENERGY ELECTRON IMPACT. Gaudin, Albert; Botter, Rene (CEN, Saclay, France). Compt. Rend., Ser. A and B, 265: 599-601(Sept. 4, 1967). (In French).

The ionization cross sections of He, Li, Be, B, C, N, O, F, and Ne were calculated following a method deduced from the Bethe treatment. The ground-state wave functions used are of the hydrogenoid type. The electron ejected is represented by a Coulomb function and the charge of the scattering center is assumed equal to 1. (tr-auth)

7171 SECONDARY IONIZATION COEFFICIENTS IN OXYGEN AT PRESSURES UP TO ATMOSPHERIC. Dutton, J.; Evans, N. B.; Morgan, G. B. (Univ. College of Swansea, Wales). Brit. J. Appl. Phys., 18: 1287-93(Sept. 1967).

The spatial increase of prebreakdown ionization currents was measured in oxygen for gas pressures in the range 93 to 650 torr and for $39.6 \leq E/p_0 \leq 50.3$ V cm^{-1} torr^{-1} (where E is the electric field and p_0 the pressure corrected to 0°C). The values of the Townsend generalized secondary ionization coefficient ω/α' determined from the measurements decreased rapidly as E/p_0 increased from 39.6 to about 46 V cm^{-1} torr^{-1} and then became relatively constant as E/p_0 increased further. Values of the apparent primary ionization coefficient α'/p_0, which were also determined as part of this investigation, increased with decreasing pressure at a constant value of E/p_0 for $E/p_0 < 43$ V cm^{-1} torr^{-1}; the significance of this variation of α'/p_0 with p_0 in the determinations of ω/α' from measurements of sparking potentials is discussed. (auth) (UK)

7172 "ENHANCEMENT FACTOR" FOR POSITRONS IN SODIUM. Donaghy, J. J.; Stewart, A. T. (Univ. of North Carolina, Chapel Hill). Phys. Rev., 164: 396-8(Dec. 10, 1967).

Experimental data from positron annihilation in sodium single crystals show (a) that the Fermi surface is spherical and (b) that the momentum dependence of the "enhancement factor" of the polarization of the electron sea by the positron agrees with calculations. (auth)

7173 FERMI SURFACE OF LITHIUM BY POSITRON ANNIHILATION. Donaghy, J. J.; Stewart, A. T. (Univ. of North Carolina, Chapel Hill). Phys. Rev., 164: 391-5(Dec. 10, 1967).

The angular correlation of radiation from positrons annihilating in lithium single crystals has been measured. The crystals were oriented in the [100], [110], and [111] directions, and the measurements yield information closely related to the areas of slices through the Fermi surface normal to these directions. The measurements show that the Fermi surface of lithium is anisotropic, the length of the radius vector k_{110} being about 5% greater than k_{100}. The measurements also yield estimates of the energy gap at the boundary of the first Brillouin zone and the amplitudes of the most important higher-momentum components of the electron wave function. (auth)

7174 AUGER ELECTRON EMISSION FROM CLEAN AND CARBON-CONTAMINATED Mo. Vance, Dennis W. (Xerox Research Labs., Rochester, N. Y.). Phys. Rev., 164: 372-80 (Dec. 10, 1967).

Measurements have been made of the Auger electron yield from polycrystalline Mo targets bombarded by mass-selected beams of Ar^+ and He^+ ions at normal incidence. The yields were measured for incident-ion kinetic energies of 50 to 400 eV. The experiments

were conducted in ultrahigh vacuum to ensure well-defined surface conditions. It was found that atomically clean Mo surfaces could not be produced by heating the targets to 2300°K, but that carbon impurities diffusing from the bulk of the sample accumulated at the surface and were not removed by heating. The carbon-contaminated surfaces gave reduced electron yields for both ions. This effect is thought to explain discrepancies among experimental results previously reported in the literature. The carbon contamination was removed by heating the target in O_2, and it is argued that the resulting surface is atomically clean. The measured thermionic work function of the carbon-covered surface was 0.4 eV greater than the clean-surface value. (auth)

7175 DENSITY EFFECT FOR THE IONIZATION LOSS OF CHARGED PARTICLES. II. Sternheimer, R. M. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 164: 349-51 (Dec. 10, 1967). (BNL-11468).

The reduction in the ionization loss of charged particles due to the polarization of the medium (density effect) has been evaluated for several additional substances, in particular for $Li_2B_4O_7$, Al_2O_3, CaF_2, NaI, CsI, lithium aluminosilicate glass, and a H_2–Ne mixture used in bubble chambers. (auth)

7176 APPROACH TO THERMAL EQUILIBRIUM THROUGH INTERACTION WITH BLACK BODY RADIATION. Oxenius, J. (EURATOM-CEA, Fontenay-aux-Roses, France). J. Quant. Spectrosc. Radiation Transfer, 7: 837-55(Nov.-Dec. 1967).

A gas immersed in black body radiation approaches its state of complete thermodynamic equilibrium through radiative processes even if collisions between particles are neglected. Einstein's investigation of atomic bound–bound transitions is extended to free–bound and free–free transitions and to Thomson scattering of free electrons. All these cases lead to a Brownian motion of the particles. Numerical values of relaxation times are calculated for hydrogen. (auth) (UK)

7177 FREE–FREE RADIATIVE TRANSITIONS: A SURVEY OF THEORETICAL RESULTS. Johnston, Robert R. (Lockheed Research Lab., Palo Alto, Calif.). Contract DASA 49-146-XZ-198. J. Quant. Spectrosc. Radiation Transfer, 7: 815-35(Nov.-Dec. 1967).

The continuous radiation absorption process generally termed "free-free absorption" and its inverse process of bremsstrahlung are of considerable importance to a wide range of physical and astrophysical problems, from cosmic ray and nuclear physics applications to the study of gas discharge and radiative transfer phenomena. A general formulation of the free–free radiative absorption cross section is presented, including discussion of the underlying physical approximations. The relation to elastic scattering is derived for low photon energies, and various simplifying approximations useful in application are discussed. (auth) (UK)

7178 DETERMINATION OF COLLISION CROSS SECTIONS OF RARE GASES FOR LEVELS OF THE 6s6d CONFIGURATION OF MERCURY ATOMS. Lecluse, Yves (Faculte des Sciences, Caen). J. Phys. (Paris), 28: 785-8(Oct. 1967). (In French).

The apparatus used to determine the radiative lifetimes of the 6s6d configuration levels of mercury has been used to study the collision of inert gases and of some molecules with mercury atoms excited in these levels. The cross sections obtained for the levels of the 6s6d configuration are practically the same for collisions with atoms of the same gas. (auth)

Cosmic Radiation

Refer also to abstracts 7092, 7104, 7125, 7127, and 7459.

7179 (AECL-2785) COSMIC RAY NM-64 NEUTRON MONITOR DATA. VII. Monthly Graphs, January–August 1967. Steljes, J. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct. 1967. 77p. Dep. CFSTI. CAN $2.00.

Uncorrected and barometer-corrected results from the cosmic-ray stations in Canada using equipment maintained by AECL are given in tabular form for the period from May to August 1967. Normalized graphs are given for the period January 1967 to August 1967. A warning about defective barometer vacuum at two stations is included. (auth)

7180 EVIDENCE FOR A NEW PRODUCTION PROCESS FOR 10^{12}-eV MUONS. Bergeson, H. E.; Keuffel, J. W.; Larson, M. O.; Martin, E. R.; Mason, G. W. (Univ. of Utah, Salt Lake City). Phys. Rev. Lett., 19: 1487-91(Dec. 25, 1967).

The intensity of cosmic-ray muons was measured as a function of depth and zenith angle in the course of a preliminary study of muon backgrounds with the Univ. of Utah neutrino detector. A brief description is given of the detector, and the factors entering into the determination of the muon intensity are discussed in detail. Comparison of the observed intensity spectra with predictions of various models yields evidence of a new production process. (L.B.S.)

7181 EXTENSIVE AIR SHOWERS OF COSMIC RADIATION. [PART II.]. Cachon, Andre; Dupuy, Jean (Observatoire du Pic du Midi, France). Nucleus (Paris), 8: 313-28(1967). (In French).

The nuclear and cosmic aspects of extensive air showers are considered. The properties of cosmic radiation at primary energies $e_p < 10^{13}$ eV are described with the consideration of the nature of the particles, energy spectra, and isotropy and intensity variations. At energies above 10^{14} eV the extensive air showers represent the only phenomenon permitting an evaluation of the energy and the frequency of arrival of primary cosmic particles. The direction of arrival and the nature of the primary particles are discussed. The most significant theories on the origin of extensive air showers are summarized. Possible future studies on relativistic phenomena produced in this energy region, thermal radiation at 3°K, and possible limitations toward 10^{20} eV of the energy spectrum are indicated. (J.S.R.)

7182 CURRENT PROBLEMS IN COSMIC-RAY PHYSICS. Wilson, J. G. (Univ. of Leeds, Eng.). Sci. Progr. (London), 55: 111-22(Spring 1967).

The place of cosmic-ray physics has changed radically in recent years as it has become closely interrelated with other methods of investigating the cosmological environment. In our immediate neighbourhood (the inner solar system) cosmic-ray effects which are determined by general features averaged over a large volume are to be related with satellite observations which refer to the situation at a given point and given time. On a galactic scale the existence of cosmic-ray primaries of the highest known energy must be related with other recognizable features, but poses problems which are not as yet met by available information. (auth)

7183 PROGRESS IN ELEMENTARY PARTICLE AND COSMIC RAY PHYSICS. VOLUME IX. Wilson, J. G.; Wouthuysen, S. A. (eds.). New York, John Wiley and Sons, Inc., 1967. 323p.

The book included four chapters. Separate abstracts were prepared for each chapter. (J.F.P.)

For abstracts of individual chapters see: 6650 and 7184–7186.

7184 DYNAMICAL ORIGIN OF THE SOLAR WIND AND COSMIC RAY VARIATIONS. Parker, E. N. (Univ. of Chicago). pp 1-38 of Progress in Elementary Particle and Cosmic Ray Physics. Vol. IX. Wilson, J. G.; Wouthuysen, S. A. (eds.). New York, John Wiley and Sons, Inc., 1967.

The general dynamical problems of the solar corona, which is heated by wave motion generated in the convection, are considered. Coronal expansion and coronal interaction with cosmic rays are discussed. The dynamic theory of this coronal expansion provides the basic processes which cause the observed cosmic ray variations. (J.F.P.)

7185 CHERENKOV RADIATION FROM EXTENSIVE AIR SHOWERS. Jelley, J. V. (Atomic Energy Research Establishment, Harwell, Eng.). pp 39-159 of Progress in Elementary Particle and Cosmic Ray Physics. Vol. IX. Wilson, J. G.; Wouthuysen, S. A. (eds.). New York, John Wiley and Sons, Inc., 1967.

Progress in the technique of studying high energy cosmic rays by detecting and measuring the Cherenkov radiation produced in the atmosphere itself is reviewed. Most of the work reviewed covers the energy range from about 10^{12} to 10^{15} eV. The difficulties of interpreting the observations and the problems of finding sites at which the desired sky clarity and constancy of clarity can be obtained are also discussed. (J.F.P.)

7186 COSMIC RAY INTENSITIES DEEP UNDERGROUND. Menon, M. G. K.; Ramana Murthy, P. V. (Tata Inst. of Fundamental Research, Bombay). pp 161-243 of Progress in Elementary Particle and Cosmic Ray Physics. Vol. IX. Wilson, J. G.; Wouthuysen, S. A. (eds.). New York, John Wiley and Sons, Inc., 1967.

Cosmic ray intensity measurements at depths greater than 2000 hg of rock (1 hg = 1 hectogram = 100 g/cm^2) and the various aspects which follow or which can be derived from these observations are reviewed. Included in the discussion are the energy spectrum of cosmic mesons (μ) at sea level and neutrino experiments deep underground. (J.F.P.)

Direct Energy Conversion

7187 (EUR-3429f) ETUDE ET DEVELOPPEMENT DE THERMOELEMENTS EN VUE DE LA MISE AU POINT D'UN GENERATEUR THERMOELECTRIQUE DE FAIBLE PUISSANCE A RADIOISOTOPES. RAPPORT FINAL. (Study and Develop-

ment of Thermo-Elements for Producing a Thermoelectric Generator with Low-Activity Radioisotopes. Final Report). Dreux, R. (European Atomic Energy Community). 1967. 35p. (In French).

The studies made of contacts between thermoelectric semiconductors and electric bonds were summarized. Studies were made on Bi_2Te_3, PbTe, and elastic contacts. The results obtained are reported in detail, especially the thermal stability of Bi_2Te_3 at 300°C. Tests on PbTe were not completed because of the difficulty of storage. A prototype thermoelectric generator using Bi_2Te_3 and heated with strontium titanate was developed. A comparative study was made between Bi_2Te_3 and PbTe. The construction specifications of a 200-MW generator, the cost, and the development planning were given for each. Various applications of generators of this power are indicated. (J.S.R.)

7188 (FOA-4-4325-55) ELKRAFTPRODUKTION GENOM MHD, NUVARANDE LAEGE OCH FRAMTIDSUTSIKTER. (Electrical Power Production by MHD: Status and Future). Witalis, E. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Nov. 1967. 13p. (In Swedish). Dep.

The results are reviewed of the comprehensive research on magnetohydrodynamic energy conversion for power production. The reasons for this research are given. The cycles are described, the open one with fossile fuels, and the closed one with nuclear fuels. Some special application of MHD power are mentioned. The experimental work to prove the physical possibilities is discussed in detail. It is concluded that the economical conditions for commercial power production by MHD will not be fulfilled. (SWED)

7189 EFFECT OF 1-MeV ELECTRON RADIATION ON SILICON SOLAR CELLS. Muel, Jacques (Centre d'Etudes Nucleaires, Grenoble, France); Roger, Jacques Sci. Ind. Spatiales, 2· No. 9-10, 39-44(1966). (In French).

Solar cells are subjected to bombardment by the charged particles of the Van Allen belt, which cause crystalline alterations in their structure and lead to a progressive lowering of output. It is necessary to construct a solar generator of such a size that it can produce all requisite power, with anticipation of the amounts of particles received, and the evaluation of their effects on the solar cells as determined by laboratory experiments. It was found possible to measure the effects of increasing doses of electrons of 1 MeV on solar cells manufactured for the Diapason 1A satellite. The experimental conditions selected made it possible to establish a correlation between the results of these measurements and those published by NASA. (IAA)

7190 THE EFFICIENCY OF MHD PROCESSES WITH INJECTION CONDENSATION. Oldekop, W.; Rex, D. (Technische Hochschule, Brunswick). Advan. Energy Convers., 7: 137-57 (1967). (In German).

Thermodynamic cycles with multistage injection condensation, which have been suggested for the supply of fast flowing liquid to liquid-metal MHD generators, are subjected to a critical calculation. A mathematical treatment of the multistage process is developed, by which any path for the process can be calculated with steady functions. This gives the possibility of varying the type of process path, as well as the start and end point of the process, by aid of a computer, in order to find the maximum possible efficiency. This maximum, $\eta = 5.35\%$, obtained from a whole of 36 different paths, is only slightly better than the efficiency of the single-stage injection condenser. Assuming a conversion efficiency of the MHD generator of 70%, the overall efficiency is only about 3 to 5%. The use of recuperative heat exchangers could be advantageous and should be theoretically treated. (auth) (UK)

7191 THERMOELECTRIC GENERATOR. (to Sanders Associates, Inc.). British Patent 1,090,830. Nov. 15, 1967. Priority date Apr. 26, 1965, United States.

An air-dropped, light-weight power supply for unattended use at ocean depths is described. A combination of thermoelectric electrical power generators mounted in a compact, shock-resistant suspension system that carries a thermal energy source arranged to deliver thermal energy in a new way is used. A unique heat-dissipating unit is included which turns itself off toward the end of the generator's life to conserve thermal energy. This is done without any mechanical moving parts. (M.H.R.)

7192 IMPROVEMENTS IN OR RELATING TO ENERGY CONVERTERS. (to CSF-Compagnie Generale de Telegraphie Sans Fil). British Patent 1,094,279. Dec. 6, 1967. Priority date Nov. 13, 1963, France.

An improved thermo-electronic converter is described wherein means are provided for applying a major portion of the incident energy flow to heat the emitter. Simultaneously a minor portion of the flow is introduced into the interelectrode space between the emitter and collector to enhance, by light photons, the ionization of the gas or vapor by electrons from the emitter. This is done without impinging directly on the surface of the collector facing the emitter. (M.H.R.)

7193 INSTALLATION FOR ACCELERATING A STREAM OF LIQUID WORKING MEDIUM. (to Licentia Patent-Verwaltungs GmbH). British Patent 1,093,585. Dec. 6, 1967. Priority date Apr. 25, 1964, Germany.

An installation is described for accelerating a stream of a liquid working medium, wherein the supplied working medium is divided into three partial streams. The first is caused to enter a heating device to be evaporated therein, the second is cooled, and the third is regeneratively heated. The second and third partial streams are injected at different points into the first partial stream after it has passed through the heating device and has been expanded. (M.H.R.)

7194 MAGNETOHYDRODYNAMIC GENERATOR MAGNET STRUCTURES. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 1,094,243. Dec. 6, 1967. Priority date Apr. 24, 1964, Germany.

A magnetohydrodynamic generator is described which includes first and second magnetic pole-pieces which have respective plane surface portions which define or are immediately adjacent to opposite side wall of the generator channel. The generator further includes coils for generating magnetic flux, the arrangement being such that when it is in operation magnetic flux generated by the coils follow paths which pass through the generator channel from the first magnetic pole-piece to the second magnetic pole-piece and return externally of the generation channel to the first magnetic pole-piece. Each such path includes externally of the generator channel a gap which contains no magnetic material. The width of this gap is not less than the shortest distance between the said respective plane surface portions. (M.H.R.)

7195 IMPROVEMENTS IN OR RELATING TO MAGNETOHYDRODYNAMIC POWER GENERATING SYSTEMS. Freck, David Vernon (to Central Electricity Generating Board). British Patent 1,092,519. Nov. 29, 1967. Filed Feb. 28, 1964.

An open-cycle MHD power generating system is described in which a fuel containing hydrogen is burned to provide combustion gases. These gases are passed through a generator duct wherein the combustion is maintained in a fuel-rich condition. This design increases the conductivity of combustion products in an MHD generator operating at a temperature of 2500°K or less. (M.H.R.)

7196 A METHOD OF OBTAINING AN UNHOMOGENEOUS FLUID STREAM FOR A MAGNETOHYDRODYNAMIC GENERATOR. (to Societe Generale de Constructions Electriques et Mechaniques (Alsthom)). British Patent 1,092,917. Nov. 29, 1967. Priority date Apr. 20, 1964, France.

A method of obtaining an unhomogeneous fluid stream for an MHD generator is described. The fuel is injected into the flow of combustion-supporting medium in two stages staggered along the path of the fluid, between which the fluid stream undergoes a partial expansion, and the two injections of fuel are effected at the same pulse frequency but with a phase displacement such that the injection of fuel in the secondary stage is applied to the sections of the fluid stream which have not been burned in the primary stage. (M.H.R.)

7197 THERMAL POWER PLANT WITH MAGNETOHYDRODYNAMIC (MHD) GENERATOR AND WASTE HEAT UTILISATION. (to Escher Wyss Aktiengesellschaft). British Patent 1,093,075. Nov. 29, 1967. Priority date Nov. 7, 1963, Switzerland.

A thermal power plant is described in which the waste heat of an MHD generator is used and the disadvantages of the combination of high temperature with high pressure are avoided. In this closed circuit thermal power plant the working medium always remains in the gaseous state and the plant incorporates an MHD generator receiving the working medium from a heater, and a turbine. The working medium leaving the generator passes successively through a precooler and a compressor, and at least a part of the medium leaving the compressor passes to the turbine and is heated by heat exchange with the medium leaving the generator. In the plant the exit pressure of the MHD generator substantially equal to the inlet pressure of the compressor and pressure prevailing in the heater never does exceed the inlet pressure of the turbine. (M.H.R.)

Fluid Physics

Refer also to abstract 7094.

7198 ELECTROGASDYNAMIC ENERGY CONVERSION. Walsh, Edward M. (Virginia Polytechnic Inst., Blacksburg). IEEE (Inst. Elec. Electron. Eng.), Spectrum, 4: No. 12, 57-62 (Dec. 1967).

Like the earlier magnetohydrodynamic (MHD) concept, EGD conversion is being seriously considered by the utilities as a possible future means for obtaining large-scale production of electric power. Probably the principal advantage of the EGD converter is that a high gas temperature is not a basic requirement. In addition, the EGD system is potentially capable of generating ac power directly at transmission-line voltages with the use of conventional or nuclear energy sources. Following a brief discussion of MHD conversion, this article reviews the basic theory of EGD conversion and describes a converter system now under development. (auth)

7199 DYNAMO WITHIN. Stubbs, Peter. New Sci., 36: 474-5(Nov. 23, 1967).

It is generally accepted that the earth's magnetic field arises from an MHD interaction in the liquid, conducting core. A new analysis of the slow changes in the earth's field reveals some of the fluid motions responsible, and implies that core-spots analogous to sunspots are formed. (auth) (UK)

7200 SLOW ROTATION OF AXISYMMETRIC SOLIDS IN MAGNETOHYDRODYNAMICS. Shail, R. (Univ. of Surrey, London). Proc. Cambridge, Phil. Soc., 63: 1331-9(Oct. 1967).

The couple on an insulated, axisymmetric solid which rotates slowly in a viscous fluid of finite conductivity is determined. The fluid is contained in an insulated vessel and there is a uniform magnetic field applied parallel to the axis of rotation. The problem is treated within the context of small perturbation theory, it being assumed that the flow is slow enough and the induced field small enough to permit linearization of the equation of motion. The results extend those of Imai and are analogous to those of Chang in the translatory case. (auth) (UK)

7201 ON THE DIFFERENTIAL EQUATION GOVERNING THE REAR STAGNATION POINT IN MAGNETOHYDRODYNAMICS AND GOLDSTEIN'S BACKWARD BOUNDARY LAYERS. Leibovich, S. (Cornell Univ., Ithaca, N. Y.). Proc. Cambridge Phil. Soc., 63: 1327-30(Oct. 1967).

Existence and uniqueness proofs for a boundary-value problem associated with a magnetohydrodynamic Falkner–Skan equation are presented. Relevant special cases of the problem herein considered include the magnetohydrodynamic rear stagnation point flow, and the non-magnetic 'backward boundary layers' of Goldstein. (auth) (UK)

7202 TEXTBOOK OF MAGNETOHYDRODYNAMICS. Shercliff, J. A. New York, Pergamon Press, 1965. 273p. $3.95.

Chapters are included on: (1) the history and character of magnetohydrodynamics (MHD), (2) the MHD approximation, (3) the kinematic aspect of MHD, (4) the magnetic force and its effects, (5) boundary and external conditions, (6) linear MHD, and (7) magnetogasdynamics. (M.O.W.)

7203 PREHEATING OF GASES SUPPLIED TO MAGNETOHYDRODYNAMIC GENERATORS. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 1,094,583. Dec. 13, 1967. Priority date July 3, 1964, Germany.

The present invention is more particularly concerned with the case in which the gas to be heated is air being supplied to the generator for combustion to produce gaseous products with which the generator operates. A method is provided for increasing the heat transfer rates from and to the molten medium. (W.D.M.)

7204 METHOD AND APPARATUS FOR MAGNETOHYDRODYNAMIC ELECTRIC POWER GENERATION. Braun, Josef (to Aktiebolaget Atomenergi). British Patent 1,094,989. Dec. 13, 1967. Priority date Dec. 20, 1963, Sweden.

The invention provides a method of producing electric power by the MHD process by passing an ionized gas through a magnetic field, including the step of ionizing the gas by passing it through a neutron irradiation zone the gas containing at least one ionizing non-fissile substance capable of reacting inelastically with neutrons to form charged particles having an energy sufficient for ionizing the gas. The gas may be ionized by passing it through a nuclear reactor. The gas may be the coolant gas of a gas cooled nuclear reactor. (W.D.M.)

7205 PREHEATING OF GASES SUPPLIED TO MAGNETOHYDRODYNAMIC GENERATORS. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 1,094,582. Dec. 13, 1967. Priority date May 2, 1964, Germany.

A means is provided for preheating of the combustion gases in a MHD arrangement by bringing them into contact with a molten liquid heated by the exit or waste gas. (W.D.M.)

Geophysics

Refer also to abstracts 7111, 7199, and 7274.

7206 (NP-17139) AN ANALYSIS OF THE EARTH'S MAGNETIC FIELD FROM 1835 TO 1965. McDonald, Keith L.; Gunst, Robert H. (Institute for Earth Sciences, Boulder, Colo.). July 1967. 87p. (IER-46-IES-1). GPO $0.50.

This work is an analysis and description of the earth's magnetic field based on observed data from the time of Gauss to the most recent epochs. An attempt was made to collect all Gauss–Schmidt coefficients of previous investigators and extensive computations were made using selections of these data. Root-mean-square representations of geomagnetic field elements are employed to depict time trends and structural dissymmetries at the earth's surface and core-mantle boundary. The analysis establishes that the magnetic dipole field is being driven destructively to smaller values by fluid motions which transform its magnetic energy into near neighboring modes rather than expend it more directly as joule heat. Concurrent with the continual decrease in field energy in the atmosphere, since 1900 at least, sixth-degree analyses indicate that the mean magnetic-energy density in the outermost layers of the core fluid has been increasing. An associated phenomenon is the continued increase in hemispheric dissymmetry, the Southern Hemisphere preponderating. Defining an asymmetry ratio, our analysis infers by extrapolation that the geomagnetic field was sensibly symmetric in 1670 A. D. The average rate of westward drift of the geomagnetic pole during the past 130 years is 0.042°/year in azimuth angle, corresponding to a polar rotation period of 8.6 thousand years. The motion appears, however, to have slowed somewhat since about 1900. The polar angle shows no progressive motions. (auth)

7207 AURORAL POLES. Bond, F. R. (Dept. of External Affairs, Melbourne). Aust. J. Phys., 20: 743-6(Dec. 1967).

The centered dipole geomagnetic poles and the eccentric dipole geomagnetic poles are established mathematical entities. In this paper the related concept of the auroral poles is outlined. The relationship of the auroral pole to the maximum iso-aurorae of the auroral zone as well as the instantaneous auroral belt is indicated. (W.D.M.)

7208 UPPER ATMOSPHERIC DENSITY IN 1966–67: THE DOMINANCE OF A SEMI-ANNUAL VARIATION AT HEIGHTS NEAR 200 km. King-Hele, D. G. (Royal Aircraft Establishment, Farnborough, Eng.). Nature (London), 216: 880(Dec. 2, 1967).

Solar activity was greater and more variable during 1967 than during 1966 and might have been expected to exercise a dominating influence over upper atmosphere density during 1967. This was not the case, however, particularly at heights near 200 km, as revealed by analysis of the orbit of the satellite Secor 6. Variations in density were apparently quite unrelated to the wide variations in the 10.7-cm radiation energy, which showed a strong 27-day recurrence over much of the satellite's life in orbit. The chief feature shown was a semiannual variation, with maxima of about 5.0×10^{-10} kg/m^3 in Oct. 1966 and April 1967, and minima of about 3.7 and 3.2×10^{-10} kg/m^3 in July 1966 and Jan. 1967, respectively. This result has significantly affected the accuracy of satellite lifetime estimates. This apparent failure of solar activity to influence upper atmosphere density at heights near 200 km. (except through the short-lived solar outbursts which give rise to geomagnetic storms) suggests that the radiation responsible for controlling this density during the declining years of the last sunspot cycle may not be as strong during the rising part of the current cycle. (UK)

7209 RECENT PROGRESS IN STUDY OF VLF AND ELF WAVES. Gendrin, R. Space Sci. Rev., 7: 314-95(Oct. 1967). (In French).

Some of the more significant theoretical and experimental studies on vlf and elf waves are reported. New theories of propagation are first discussed. The results obtained on the density and the composition of the magnetosphere from a study of the propagation are discussed. Interaction mechanisms relative to vlf emissions are considered and some relations on the gyro resonance interactions are established. (J.S.R.)

7210 DETERMINATION OF THE FLUX OF PRIMARY COSMIC RAY HYDROGEN AND HELIUM NUCLEI NEAR THE GEOMAGNETIC EQUATOR USING NUCLEAR EMULSIONS. II. Kajarekar, P. J. (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A, 64: 123-7(Sept. 1966).

The flux of helium nuclei of the primary cosmic radiation at the top of the atmosphere has been determined over Hyderabad, India, at a time of high solar activity in the 11-year cycle (Mar. 24, 1960). The flux value has been found to be 17.9 ± 1.9 helium nuclei/m^2-sec-ster, corresponding to a vertical geomagnetic cut off energy of 7.5 GeV/nucleon. This result when compared with other observations made near the geomagnetic equator shows that the

solar modulation effects, if any, at rigidities >16 GV should be ≲10% only. (auth)

7211 PLASMA MEASUREMENTS IN THE UPPER ATMOSPHERE WITH THE IMPEDANCE PROBE. Oyo, Hiroshi; Obayashi, Tatuzo (Tokyo Univ.). Tokyo Daigaku Uchu Koku Kenkyusho Hokoku, 2: 1065-79(Sept. 1966). (In Japanese).

Development of the theory of impedance probing in the elf to hf range for diagnosing the plasma in space is considered. It is predicted by this theory, which treats the plasma as a special dielectric, that the gyro resonance frequencies and the hybrid resonance frequencies can be determined without disturbance due to the existence of the ion sheath and without disturbance of attitude variation relative to the magnetic field. (IAA)

Low-Temperature Physics

Refer also to abstracts 6984 and 7603.

7212 (NYO-2028-2, pp 139-49) USE OF A CLOSED-CYCLE HELIUM REFRIGERATOR FOR MOESSBAUER STUDIES. Wiggins, J. W.; Oleson, J. R.; Lee, Y. K.; Walker, J. C. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics). (NYO-2028-9).

A closed-cycle helium refrigerator was used successfully to cool the target and absorber in Coulomb excitation Mössbauer studies. The refrigerator handles the appreciable power from the beam and may be used at any temperature above 20°K. The most severe problem of mechanical vibration has been solved. (auth)

7213 (NYO-2150-36) FIELD ANALYSIS OF A SUPERCONDUCTING SOLENOID MAGNET UTILIZING NUCLEAR MAGNETIC RESONANCE. Report 821. Steele, Edward Eugene (Cornell Univ., Ithaca, N. Y. Materials Science Center). Jan. 1968. Contract AT(30-1)-2150. 70p. Dep. CFSTI.

Thesis.

$Nb_{75}Zr_{25}$, a type-II superconductor, has been found to be a suitable material out of which to make superconducting magnets. These magnets are capable of producing very large magnetic fields (>10 kG). Several of the properties of such magnets are investigated. The nature of the superconducting state of type-II superconductors is also investigated. The critical fields and the critical temperature of the type-II alloy $Pb_{85}In_{15}$ are measured. This PbIn alloy was used purely to simplify the experimental procedure; the results are applicable to other type-II materials, and, in particular, to NbZr. A field calibration technique which utilizes nuclear magnetic resonance is described. A marginal oscillator system is used which is capable of measuring fields from 1.5 to 60 kG easily. Suggestions of possible improvements over the present system are made. The homogeneity, linearity, reproducibility, and hysteresis of a 55-kG Westinghouse uncorrected solenoid magnet are studied with this NMR calibration system. The results are compared to field calculations based on the geometry of the solenoid. The field characteristics of the superconducting solenoid are also compared with iron electromagnets and Bitter magnets. (auth)

7214 SUPERCONDUCTING RESONATOR SOLENOID. Blagosklonskaya, L. E.; Gershenzon, E. M.; Serebryakova, N. A.; Shebalin, I. Yu. (Moscow State Pedagogical Inst.). Prib. Tekh. Eksp., No. 4, 256-7(July-Aug. 1967). (In Russian).

A resonator-solenoid, combining in itself a superconducting solenoid and high-quality spiral resonator, was described. It has a cylindrical surface which forms the internal part of the winding coil of the solenoid. (tr-auth)

7215 ORDER-DISORDER TRANSFORMATION IN Pb-Tl AND Pb-In ALLOYS. Gamari-Seale, Helen (Imperial Coll. of Science and Tech., London). J. Phys. Soc. Jap., 23: 898(Oct. 1967).

The superconducting transition temperature, T_c, of a number of Pb-Tl and Pb-In alloys in the region of 25 and 75 at. % Pb respectively were measured in order to find whether any order superstructure exists. (M.O.W.)

7216 MAGNETIZATION OF THE SUPERCONDUCTING SHEATH. Joseph, A. S.; Thorsen, A. C.; Gertner, E. R.; Savage, J. W. (North American Aviation Science Center, Thousand Oaks, Calif.). Phys. Rev. Lett., 19: 1474-8(Dec. 25, 1967).

Torque measurements on type-II superconducting foils in nearly parallel applied magnetic fields H indicate that the torque above H_{c2} can provide a direct measure of the magnetization. From the results above H_{c2} two magnetizations are deduced, M_b associated with the bulk sample, and M_s associated only with the superconducting sheath. The measurements indicate that M_s is irreversible with H, contrary to prediction, and that the sheath itself behaves as if it is multiply connected. (auth)

7217 NONMAGNETIC LOCALIZED STATE IN ALUMINUM. I. SUPERCONDUCTING TRANSITION TEMPERATURE. Aoki, Ryozo; Ohtsuka, Taiichiro (Tokyo Univ.). J. Phys. Soc. Jap., 23: 955-64(Nov. 1967).

The change in T_c of the superconducting transition temperature of aluminum due to the addition of 3d transitional impurities Ti, V, Cr, Mn, Fe, and Ni is measured as a function of the residual resistance ratio ρ in the region of dilute concentrations ranging from 0.001 to 0.04 at. %. The contribution due to the smearing out of the energy-gap anisotropy $(\Delta T_c)_{anis}$ is estimated by assuming that it can be accounted for by the theory of Markowitz and Kadanoff. $(\Delta T_c)_{anis}$ thus estimated is found to depend only on the mean free path and very little on the type of impurity. The remaining part, $(\Delta T_c)_\gamma$ obtained by subtracting $(\Delta T_c)_{anis}$ from the observed change in the transition temperature, is found to be negative showing a dependence on impurity similar to that found for the residual resistance but differing that it shows a rather sharp minimum at Mn. Comparisons with theories based on the Anderson model of localized states in metals are made. It is shown that the overall behavior shows fair agreement with theories that include the effect of the d-d Coulomb correlation energy. (auth)

7218 PARAMAGNETIC IMPURITY EFFECT IN DILUTE SUPERCONDUCTING La-ALLOYS. Sugawara, Tadashi; Eguchi, Hiroko (Tokyo Univ.). J. Phys. Soc. Jap., 23: 965-74(Nov. 1967).

The superconducting transition temperatures and the critical fields have been measured by the magnetic method in a number of dilute superconducting La-Ce and La-Gd alloys to study the magnetic impurity effect. The concentration dependence of the transition temperature shows a deviation from the Born approximation value in the Abrikosov-Gor'kov theory and this deviation is dependent upon the sign of the s-f exchange integral of the impurity. This result is regarded as an evidence for the Kondo effect in superconductivity. Magnetic behaviors characteristic of the inhomogeneous type-II superconductors have been observed in pure La and the alloys. Comparison of the upper critical field data with the theory of Fulde and Maki leads to a conclusion that the transport resistivity of La does not increase with impurity concentration. The Ginzburg-Landau parameter of α La at T_c is about 3.4 and decreases with increasing impurity concentration in accordance with Maki's theoretical prediction. (auth)

7219 PROXIMITY EFFECT OF SUPERCONDUCTING SUPERIMPOSED FILMS. Tsuya, Hideki (Nippon Electric Co., Ltd., Kawasaki, Japan). J. Phys. Soc. Jap., 23: 975-82 (Nov. 1967).

The proximity effects of superimposed films were examined by the electron tunneling on the side of the superconductor backed with a normal metal. Gapless superconductivity was observed in the Ag-Sn and Fe-Sn systems directly from the current vs. voltage curves and also in the Pb-Ag and Pb-Fe systems from the dynamic resistance vs. voltage curves. A magnetic metal such as iron has a larger effect on the energy gap and the density of states than a normal metal such as silver. The density of states taken from the dynamic resistance vs. voltage curves was analyzed simply by replacing the collision rate in the theory of Skalski et al. for the superconductor containing paramagnetic impurities by the pair breaking parameter in the Fulde-Maki theory for a superimposed film. The agreement with the theory was good in the nonmagnetic normal-superconducting system, but was rather poor in the magnetic normal-superconducting system. (auth)

7220 MAGNETOCALORIC EFFECT AND THE UPPER CRITICAL FIELD OF SUPERCONDUCTING NIOBIUM. Ohtsuka, Taiichiro; Takano, Nobuyoshi (Tokyo Univ.). J. Phys. Soc. Jap., 23: 983-98(Nov. 1967).

The reversible magnetocaloric effect observed in the mixed state of a high-purity niobium single crystal is shown to yield precise values of the upper critical field H_{c2} corresponding to a second-order phase transition together with other properties of the mixed state. Measurements of H_{c2} from about 0.3°K to T_c = 9.23°K are reported. Extrapolation to 0°K gives H_{c2} = 4035 Oe, whereas precise measurements near T_c give for the initial slope, $-(dH_{c2}/dT)_{T\sim T_c}$ = 531Oe/°K. Analysis of the results in terms of microscopic theory shows that reported disagreements pertaining to $H_{c2}(0)$ may be accounted for by deviations of the quantities related to the superconducting ground state from BCS laws. Brief accounts of the Ginzburg-Maki parameter κ_2 derived from magnetocaloric measurements and results obtained on a deformed crystal are given. (auth)

7221 OPTICAL OBSERVATION OF SECOND SOUND IN He II. Jacucci, G.; Signorelli, G. (Univ., Rome). Phys. Lett., 26A: 5-6(Dec. 4, 1967).

The diffraction of a laser light beam by a generated continuous second sound wave in liquid helium II according to the Debye-Sears effect was observed. (auth)

7222 SOLUTION OF GINZBURG–LANDAU EQUATIONS FOR ARBITRARY TANGENTIAL MAGNETIC FIELDS AND EXPERIMENTAL VERIFICATION. Alphonse, Gerard A. (RCA Labs., Princeton, N. J.); Bergstein, Leonard. J. Appl. Phys., 38: 5097-5103(Dec. 1967).

The Ginzburg–Landau equations are solved for thin superconductors in the presence of arbitrary tangential magnetic fields and yield an essentially position-independent order parameter if the superconductor contains no vortices. The magnetic transition is always first order unless the field is symmetrical on the surface; if the field comes from a superposition of external source and transport current, the critical order parameter Φ_c is a one-third power function of the current. It is shown that the physical conditions for the above solution can be realized with a superconducting transmission line, and that the order parameter is directly measurable in terms of the resonant frequency of the line. The measurements made on tin samples at temperatures down to $0.6T_c$ show excellent agreement with the theory, and constitute an experimental verification of the latter. (auth)

7223 SUPERCONDUCTIVITY IN THIN INDIUM FILMS. Vogel, H. E.; Garland, M. M. (Clemson Univ., S. C.). J. Appl. Phys., 38: 5116-24(Dec. 1967).

Superconducting indium films are studied to determine the effect of film thickness on transition temperature in the range of thicknesses from about 100 to about 1000 A. Films of varying thicknesses are produced by vacuum deposition onto z-cut quartz substrates. To ensure reproducibility, films are produced in groups of five. Comparisons are made with the theoretical models of Toxen and Strongin et al., and the effect of electron mean free path is calculated in an approximate manner. In addition, an effective electron–phonon coupling constant is obtained for the surface-layer model. (auth)

7224 MACROSCOPIC QUANTUM PHENOMENON. Pitaevskii, L. P. Usp. Fiz. Nauk, 90: 623-9(Dec. 1966). (In Russian).

Since the end of the twenties, when the science of quantum mechanics was elaborated, the development of theoretical and experimental physics has been divided between the classical and quantum-mechanical approach. Quantum mechanics forms the basis of microscopic, i.e., atomic and nuclear, phenomena, while the classical method is sufficient to explain the motion of large amounts of material. Planck's constant, $\hbar$, does not enter into the equations describing the motion of solids, liquids and gases and therefore, it can be measured only in experiments involving atomic phenomena. However, the motion of liquid ^{3}He cannot be explained by the classical theory. The problem of superfluidity and turbulence of that liquid was therefore analyzed. Quantizing of the magnetic flux in superconductors was also examined, pointing out the common aspects of superfluidity and superconductivity. (Review article, 7 references). (TTT)

7225 EVIDENCE FOR A PEELING MODEL OF VORTEX RING FORMATION BY IONS IN LIQUID HELIUM. Rayfield, G. W. (Univ. of Oregon, Eugene). Phys. Rev. Lett., 19: 1371-3(Dec. 11, 1967).

An experiment is described which indicates that the ion–vortex-ring transition is smoothly connected with no discontinuities in the drift velocity of the ion complex when the critical velocity for vortex-ring formation is reached. The data indicate that the vortex line associated with the formation of the vortex ring is slowly peeled away from the ion in the form of a steadily growing loop as the electric field is increased. Thus, no sudden change in drift velocity is observed nor is the ion required to hop onto the ring since it is always trapped on the core (or, conversely, one may say the vortex line formed is always stuck to the ion). (M.H.R.)

7226 OSMOTIC PRESSURE OF DILUTE SOLUTIONS OF ^{3}He IN ^{4}He. Wilson, M. F.; Edwards, D. O.; Tough, J. T. (Ohio State Univ., Columbus). Phys. Rev. Lett., 19: 1368-71(Dec. 11, 1967).

The osmotic pressure of dilute solutions of ^{3}He in liquid ^{4}He has been measured at 0.320, 0.650, and 1.16°K for ^{3}He concentrations up to 2%. The results do not agree well with the calculations of Ebner based on the effective potential of Bardeen, Baym, and Pines. (auth)

7227 SUPERCONDUCTIVITY IN HYDRIDES WITH A-15 STRUCTURE. Vetrano, J. B.; Guthrie, G. L.; Kissinger, H. E. (Battelle Memorial Inst., Richland, Wash.). Phys. Lett., 26A: 45-6(Dec. 4, 1967).

A-15 structure hydrides with the formulations of Ti_3AuH and $Ti_3AuH_{2.8}$ were prepared and examined for superconductivity. The former has an electron-to-atom ratio generally considered favorable for superconductivity. Neither of the preparations was superconducting down to 1.6°K. (auth)

7228 TEMPERATURE DEPENDENT INTERACTION IN SUPERCONDUCTORS EFFECT ON LAW OF CORRESPONDING STATES. Rothwarf, A. (RCA Labs., Princeton, N. J.). Phys. Lett., 26A: 43-4(Dec. 4, 1967).

Due to the temperature dependence of the energy gap the Eliashberg interaction potential has an intrinsic temperature dependence which causes appreciable changes in $2\Delta(0)/kT_{cj}$ values larger and smaller than the BCS value occur. (auth)

7229 ABSORPTION OF SOUND IN HELIUM II BELOW 0.6°K. Waters, G. W.; Watmough, D. J.; Wilks, J. (Oxford Univ.). Phys. Lett., 26A: 12-13(Dec. 4, 1967).

The absorption of sound in helium II was measured at frequencies of 20.7 and 61.1 MHz, down to 0.1°K. Below 0.2°, the absorption may be written $\alpha = (1.1 \pm 0.1) \times 10^{-6}\ \omega T^4 dB/cm$, where ω is the angular frequency and T the absolute temperature. (auth)

7230 EXPERIMENTAL STUDIES OF NEW SUPERCONDUCTING Ti–Nb–Ta ALLOY WIRES. Komata, Toranosuke; Ishihara, Katsumi (Mitsubishi Electric Corp., Japan). Mitsubishi Denki Lab. Rep., 41: 745-50(June 1967). (In Japanese).

Superconducting materials and magnet systems have been studied for years, and new superconducting Ti–Nb–Ta alloy wires have been successfully developed. The upper critical field of Ti–Nb–Ta alloy is about 125 kG, which is the highest of known alloy superconductors. The alloy also has a higher transition temperature than Ti–Nb binary alloy, about 10°K. It has been found that appropriate heat treatments lead the wire to have the highest critical-current density, 1.3×10^5 A/cm^2 at 50 kG in short sample tests, due to the precipitation or clustering processes. Tests have been conducted on a magnet 30 mm in inner diameter and 120 mm in coil length wound with the new alloy wire. The field intensity of this magnet reaches 60 kG without instability and with relatively small current degradation. (auth) (NSA of Japan)

7231 SUPERCONDUCTIVITY AND SPECIFIC HEAT OF TITANIUM–RHODIUM ALLOYS. Dummer, Gerald; Oftedal, Eyvinn (Technische Hochschule, Karlsruhe, Ger.). Z. Phys., 208: 238-48(1968). (In German).

The specific heats of Ti–Rh alloys have been measured between 0.9 and 8°K for atomic percent Rh concentrations between 0 and 10. The transition temperatures of the hexagonal (0 to 2 at. % Rh) and the cubic (3 to 10 at. % Rh) phases are given by calorimetric measurements. The transition temperature and the electronic specific heat increase with Rh concentration. The influence of the rate of cooling on the transition temperature has been studied for some alloys. The electrically, magnetically, and calorimetrically determined transition temperatures are compared. Contrary to Hf_3Rh and Zr_3Rh down to 1.2°K Ti_3Rh has not been observed to become superconducting. (auth)

7232 SUPERCONDUCTIVITY OF VANADIUM, NIOBIUM, AND TANTALUM AT HIGH PRESSURES. Koehnlein, D. (Technische Hochschule, Karlsruhe, Ger.). Z. Phys., 208: 142-58(1968). (In German).

The influence of high hydrostatic pressure on the transition temperature T_c has been investigated for the superconductors of group Vb of the periodic table up to 45 kbars. Results obtained for tantalum, showing a negative pressure effect dT_c/dp, are in good agreement with earlier observations. For vanadium and niobium, however, dT_c/dp is found to be positive with an initial slope 1.76×10^{-5}K/bar and 1.2×10^{-5}K/bar respectively. In addition, a very strong influence on T_c and dT_c/dp of lattice defects produced by plastic deformation at low temperatures has been observed for V and Nb. Comparatively small increases of the residual resistance yield an increase of T_c and a pronounced minimum in the T_c–p dependence for both metals. The results are discussed with regard to possible influence of pressure on the density of states and the Debye temperature. (auth)

7233 PAIRING INTERACTION IN THE THEORY OF SUPERCONDUCTIVITY. Cooper, Leon N. (Brown Univ., Providence). pp 277-99 of Cargese Lectures in Physics, Volume 1. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

A brief history of the development of superconductivity theory, the electron–electron interaction due to phonon exchange, the Hamiltonian for pairing, evidence for pairing, and series expansions for strongly coupled systems are considered. Also discussed are subsets of graphs, a criterion for the validity of many-body approximations, and the classification of graphs. (J.F.P.)

7234 FLUX DIFFUSION IN SUPERCONDUCTING NIOBIUM. Letellier, B. P.; Rocher, Y. A. (Alcatel, Bruyeres-le-Chatel, France). Solid State Commun., 5: 879-82(Nov. 1967).

The early stage of flux penetration was studied in pure superconducting niobium. Penetration begins at H_{c1} but remains ex-

tremely slow [(dB/dt) < 1 G/sec] until the external field reaches the superheating field value, H_{SH}. In fields above H_{SH}, the penetration rate dB/dt exhibits an exponential decay and the associated time constant decreases exponentially as the external field increases. (auth)

7235 UNSTEADY-STATE HEAT GENERATION AND HEAT TRANSFER IN SUPERCONDUCTING COMPOSITES. Gardner, G. C. (Central Electricity Research Labs., Leatherhead, Eng.). Int. J. Heat Mass Transfer, 10: 1055-64(Aug. 1967).

Approximate methods are developed to calculate the rate of heat generation with respect to time when current is suddenly discharged from part of a superconducting wire embedded in a copper sheath. The temperature field in the copper with respect to time is then found in the absence of any cooling from liquid helium surrounding the superconducting composite. It is thus determined if the temperature at the end of the section of superconductor from which the current has been excluded rises above a critical temperature that will cause the region to propagate. Unsteady-state film boiling of liquid helium is separately considered to determine if it can make a significant contribution to modifying the temperature field within the superconducting composite. The film boiling theory is put in a form readily applicable to liquids other than helium. (auth) (UK)

7236 MEISSNER EFFECT IN THIN PLATES OF TYPE-II SUPERCONDUCTORS. Lowell, J.; Sousa, J. B. (Oxford Univ.). Solid State Commun., 5: 829-31(Nov. 1967).

The Meissner effect in thin plates of type-II superconducting alloys was studied as a function of the angle between the magnetic field and the sample plane.. The results suggest that a surface barrier is effective in preventing fluxoid exit, providing that the fluxoids do not intersect the sample surface. (auth) (UK)

7237 SUPERCONDUCTIVITY OF $CeCo_2$. Smith, T. F.; Harris, I. R. J. Phys. Chem. Solids, 28: 1846-9(Sept. 1967).

It is reported that the cubic (C15) Laves phase $CeCo_2$, is a superconductor with $T_c = 0.84 \pm 0.04$°K. The substitution of Rh or Ni for Co in $CeCo_2$ results in a rapid reduction of T_c. Superconductivity was not detected above 0.33°K in alloys in which 33.3% of the Co had been replaced. It is suggested that the decrease of T_c appears to be due to an increase in the magnetic 4f character of the Ce atoms, as the Co atoms are replaced by Rh or Ni. (UK)

7238 MOTION OF THE VORTEX STRUCTURE IN TYPE-II SUPERCONDUCTORS IN HIGH MAGNETIC FIELD. Caroli, Christiane; Maki, Kazumi (Univ. of California, San Diego). Phys. Rev., 164: 591-607(Dec. 10, 1967).

The resistive state in type-II superconductors in a high field was studied microscopically in two extreme limits (i.e., the dirty limit and the pure limit). It was established that in a high magnetic field, a constant electric field induces (1) a uniform motion of the order parameter in the direction perpendicular to both the electric and the magnetic fields with velocity $-u = -E/H_{c2}$, and (2) a polarization along the electric field proportional to this velocity. This gives rise to additional contributions to the electric and thermoelectric transport coefficients. The changes of longitudinal resistivity and Ettinghausen coefficient due to the above effect were calculated in both limits. In the pure limit, the variations of the Hall angle and the Peltier coefficient were also obtained. (auth)

7239 THERMOMAGNETIC EFFECTS IN SUPERCONDUCTORS. Solomon, P. R.; Otter, F. A. Jr. (United Aircraft Research Labs., East Hartford, Conn.). Phys. Rev., 164: 608-18 (Dec. 10, 1967).

Transport properties of superconductors in the mixed state and the intermediate state are discussed. A phenomenological model for the thermomagnetic effects occurring when vortices are free to move is outlined. These effects involve the entropy transported by moving vortices. The measurement of two effects that are abnormally large in a superconductor, the Ettinghausen effect and the Nernst effect, is described. Both effects have been measured as functions of magnetic field and temperature in a type-II alloy (In + 40 at. % Pb), and the Ettinghausen effect has been measured in a type-I alloy (Sn + 0.05 at. % In). The values of transported entropy per cm of flux line per flux quantum computed from these measurements are compared with existing theories. For both type-I and type-II superconductors, the theories agree roughly with the measurements at low temperatures but fail to agree near T_c. (auth)

7240 ANOMALIES IN THE MAGNETIC FIELD DEPENDENCE OF THE SURFACE IMPEDANCE OF SUPERCONDUCTING Sn. Koch, J. F.; Kuo, C. C. (Univ. of Maryland, College Park). Phys. Rev., 164: 618-27(Dec. 10, 1967).

An extensive study was made of the microwave surface resistance of superconducting Sn as a function of magnetic field. At reduced temperatures $t \gtrsim 0.6$ and microwave frequencies in the range of 28 to 56 Gc/sec, some unusual peaks in the absorption derivative were found. The anomalous peaks appear at the onset of a range of magnetic field where the resistance decreases with increasing field. The position in field for such a peak is found to vary with temperature approximately as $(1 - t^4)^{\frac{1}{2}}$. The amplitude diminishes rapidly with decreasing temperature. The peak position depends linearly on the microwave frequency. The effect is anisotropic with respect to the orientation of the magnetic field in a given sample plane, as well as with the choice of sample plane for a given orientation of the field. The amplitude of the peaks depends on the polarization of the rf current relative to the magnetic field. A very light etching of the sample surface destroys the signals. The effect is interpreted in terms of magnetic-field-induced surface bound states that correspond to classical skipping orbit trajectories. Such states are shown to have energies in the gap of the energy spectrum of the superconductor. Transitions between the bound state and the continuum above the energy gap can satisfactorily account for the experimental observations. Indeed, the experiments are believed to provide evidence for the existence of surface states in the presence of a magnetic field. (auth)

7241 THERMODYNAMIC FLUCTUATIONS OF THE ORDER PARAMETER IN TYPE-II SUPERCONDUCTORS NEAR THE UPPER CRITICAL FIELD H_{c2}. Eilenberger, Gert (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 164: 628-35(Dec. 10, 1967).

The mean-square deviation of the order parameter from its equilibrium for type-II superconductors is investigated, assuming that the Gibbs free energy is given by a Ginzburg–Landau-type functional. It turns out that the equilibrium function, which is already varying with position because of the penetrating magnetic flux, resists distortion much less than the constant order parameter in type-I superconductors. Therefore, the mean-square deviation becomes equal in magnitude to the square of the equilibrium order parameter in the magnetic field range $(H_{c2} - B)/H_{c2} \lesssim 10^{-4}$ to 10^{-5}. This means that the range of magnetic fields in which Ginzburg–Landau-type descriptions should fail and a singular behavior might show up seems not entirely out of reach of present experimental techniques, in contrast to the situation in type-I superconductors. It is shown that in the limit as B goes to H_{c2}, the equilibrium function corresponding to a triangular fluxoid lattice gives a local minimum of the free energy in function space; and an orthogonal set of fluctuations of the equilibrium function, which are normal modes in the sense that the second-order increment of the free energy does not mix their amplitudes, is obtained. The special properties of the most important fluctuations suggest that the vortex crystal melts slightly below H_{c2}, but that the identity of the vortices is maintained. (auth)

7242 PREDICTED TRANSITION TEMPERATURES OF VERY THIN FILMS AND WHISKERS OF SUPERCONDUCTING SEMICONDUCTORS: APPLICATION TO $SrTiO_3$. Eagles, D. M. (Post Office Research Station, London). Phys. Rev., 164: 489-97(Dec. 10, 1967).

Approximate solutions of the BCS energy-gap equation with constant kernel are found for superconducting semiconductors at carrier concentrations such that the distance of the Fermi level above the bottom of the band is less than or of the order of the relevant phonon energy. Results of Tavger and Demikhovskii for the energy gap in effectively two-dimensional films are generalized to all values of the Fermi energy, and approximate gaps for effectively one-dimensional whiskers are calculated. Screening by free carriers in quasi one- and two-dimensional systems is studied by the Lindhard method; the results lend some support to the hypothesis that in many-valleyed semiconductors the interaction strength between electrons will not be greatly altered by production in suitably oriented thin-film or whisker form. With the usual BCS relation between transition temperature and energy gap, and using a simple model with an interaction equal to a constant for electrons within a phonon energy 0.099 eV of the Fermi level and zero otherwise, an effective interaction strength V as a function of carrier concentration in bulk $SrTiO_3$ is deduced from published experimental results on concentration dependence of transition temperature in this material. Hence, assuming a localized interaction of the same strength occurs in effectively two-dimensional films or one-dimensional whiskers, which assumption implies, respectively, effective interactions V_2 and V_1 given by $V_2 = \frac{3}{2}V$ and $V_1 = (\frac{3}{2})^2V$, transition temperatures for films and whiskers are predicted as a function of carrier concentration for several different thicknesses. Transition temperatures higher than those of any known superconductor are predicted on this model for (111) films of 7 and 14 Å thicknesses, and for [111] whiskers of (7 Å)², (14 Å)², and (21 Å)² cross sections, but at such small thicknesses the model can be expected to give only indications of trends. (auth)

7243 INTRINSIC RESISTIVE TRANSITION IN NARROW SUPERCONDUCTING CHANNELS. Langer, J. S.; Ambegaokar, Vinay (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 164: 498-510(Dec. 10, 1967).

A theory of current-reducing fluctuations in narrow superconducting channels is presented. The theory is based on the Ginzburg–Landau equation, and is constructed in analogy with the droplet model of the condensation of a supersaturated vapor. The theory suggests that large and improbable fluctuations are important, and cause measurable departures from the mean-field critical current. The calculation leads to a concrete result for the intrinsic resistive transition. This transition is predicted to occur at a temperature slightly lower than the bulk transition temperature, and to have a width that is observable but smaller than those measured in recent experiments. (auth)

7244 ELECTRON-TUNNELING MEASUREMENTS ON LANTHANUM AND LANTHANUM–LUTETIUM ALLOY FILMS. Edelstein, A. S. (IBM Watson Research Center, Yorktown Heights, N. Y.). Phys. Rev., 164: 510-17(Dec. 10, 1967).

Results of electron tunneling measurements on evaporated films of fcc lanthanum and dhcp lanthanum–lutetium alloys are presented. The ratio of the zero-temperature energy gap to the temperature at which the energy gap vanishes for both the pure lanthanum and lanthanum–lutetium alloy samples varied from 3.41 to 3.58. If one fits the lowest-temperature data for the energy gap with a curve of the BCS temperature dependence, the values at intermediate temperatures fall below the weak-coupling BCS prediction. The conductance maxima for the (pure La)–Al_2O_3–Al diodes are larger than predicted by the weak-coupling BCS theory. The conductance maxima for the lutetium alloy samples are more nearly equal to the weak-coupling BCS values than are those of the pure samples. They were not significantly altered by the presence of small zero-voltage anomalies. Hence zero-voltage anomalies are not enhanced at temperatures below the superconducting transition temperature. No change in conductance as large as 0.1% was observed, which could be associated with the second energy gap predicted by the multiband-superconductor theory of Kuper, Jensen, and Hamilton. Kondo's multiband-superconductor theory is consistent with the experimental results. It is shown that if the f band in Kondo's theory is approximately 20 MeV or more higher than the Fermi level, then Kondo's theory reduces to a single-parameter theory having a gap equation identical in form to the BCS gap equation. (auth)

7245 ANALOG-COMPUTER STUDIES OF JOSEPHSON RADIATION EFFECTS. Werthamer, N. R.; Shapiro, Sidney (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 164: 523-35(Dec. 10, 1967).

Equations characterizing a Josephson junction coupled to a resonant cavity driven by an rf voltage have been programmed for an electronic analog computer. Modifications in the dc V–I characteristic of the junction, for both constant-voltage and constant-current load lines, as well as the power spectrum in the cavity, were observed as a function of the parameters: resonance frequency and Q of the cavity, frequency and amplitude of the applied rf voltage, and strength of coupling between junction and cavity. Many of the nonlinear, parametric effects observed can also be understood analytically on the basis of the approximation that the cavity electric field contains only a single frequency component. (auth)

7246 FLUX-FLOW RESISTIVITY IN A SUPERCONDUCTING DISK. Shaw, M. P.; Solomon, P. R. (United Aircraft Research Labs., East Hartford, Conn.). Phys. Rev., 164: 535-7(Dec. 10, 1967).

The flux-flow resistivity of a type-II superconductor in the mixed state was studied by passing a symmetric radial current through a superconducting disk. The experiment verified that current-induced flux flow does not require a gradient in the density of flux lines in the direction of flux motion. (auth)

7247 VORTEX STRUCTURE AND CRITICAL CURRENTS IN JOSEPHSON JUNCTIONS. Owen, C. S.; Scalapino, D. J. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 164: 538-44(Dec. 10, 1967).

The maximum current that can be carried by a long unbiased superconducting tunnel junction as a function of applied magnetic field has been calculated. A symmetric junction geometry was assumed for which the boundary conditions relate the space derivatives of the phase difference ϕ at the two ends. In addition the current density distribution within the junction when the total current is maximum is graphed, and the shape of the current vortices in the large-field case and the details of the self-limiting of the tunnel current as a function of junction length in zero applied field are shown. (auth)

7248 MEISSNER EFFECT AND VORTEX PENETRATION IN JOSEPHSON JUNCTIONS. Goldman, A. M.; Kreisman, P. J. (Univ. of Minnesota, Minneapolis). Contract AT(11-1)-1569. Phys. Rev., 164: 544-7(Dec. 10, 1967). (COO-1569-10).

Investigation of the magnetic-field dependence of the maximum zero-voltage current of wide, high-current Josephson junctions has revealed behavior drastically different from the usual Fraunhofer pattern for narrow junctions. The experiments are interpreted as evidence for a Meissner effect for the insulating layer and adjacent penetration layers of wide junctions in low external fields, and for an eventual transition to a mixed state as the external field is increased from zero. (auth)

7249 EFFECT OF RESONANCE SCATTERING AND IMPURITY CORRELATIONS ON THE THERMODYNAMIC AND TRANSPORT PROPERTIES OF SUPERCONDUCTING ALLOYS. Kiwi, M.; Zuckermann, M. J. (Univ. of Virginia, Charlottesville). Phys. Rev., 164: 548-57(Dec. 10, 1967).

A model due to Anderson is used to investigate the superconducting properties of nonmagnetic alloys of simple metals with transition-metal impurities. The alloys are assumed to be very dilute. The resonance-scattering effects in the alloys are related to the width Γ of the bound d state on each impurity, and the physical limit $\Gamma \gg kT_c$ is chosen. Here T_c is the superconducting critical temperature of the alloy. The impurity correlations are dependent on the Coulomb interaction U between d electrons on opposite spin, and are included in the superconducting problem by a self-consistent Hamiltonian due to Ratto and Blandin. The order parameter, the electronic density of states $N(\omega)$, and the specific heat are calculated for the superconducting state of the alloys at temperatures T such that $0 \lesssim T \ll T_c$. It is found that $N(\omega) \sim (\omega - \omega_G)^{\frac{1}{2}}$ close to the gap edge ω_G, and that U has a strong effect on the thermodynamic properties of the alloys in this temperature range. The thermodynamic properties are also investigated in the temperature range $0 \ll T \lesssim T_c$. It is found that they depend on the impurity correlations only through T_c. However, the transport properties of the alloys are strongly U-dependent for these temperatures, in particular the Josephson current. Finally, the relation to the Kondo effect is discussed and the results of the paper are considered in the light of experiment. (auth)

7250 GAPLESS SUPERCONDUCTIVITY INDUCED BY THE PROXIMITY EFFECT. Hauser, J. J. (Bell Telephone Labs., Murray Hill, N. J. Phys. Rev., 164: 558-65(Dec. 10, 1967).

The tunneling characteristics of Al–Al_2O_3–Pb–M junctions (where M was respectively Ni, Fe, and Pt) were studied as a function of temperature and of the lead film thickness. In the case of Pb–Ni and Pb–Fe sandwiches, the lead film is gapless and the ratio of the conductances at zero bias in the normal and superconducting states approaches unity linearly as the temperature approaches T_c (the sandwich transition temperature). The slope of this linear portion is proportional to $C(t_c)$, which is a universal function of $t_c = T_c/T_{c1}$, where T_{c1} is the transition temperature of pure lead. In agreement with theory $C(t_c)$ approaches 2 as t_c approaches unity; but sandwiches with $t_c < 1$ are found to be more gapless than predicted by theory. The same conclusions apply to Pb–Pt sandwiches, which exhibit quasigapless superconductivity. Finally, Pb–Pt and Pb–Ni sandwiches with the same T_c display the same degree of gapless superconductivity. On the other hand, Josephson tunneling experiments were performed with Cr–Pb–PbO–Pb–Cr junctions. Although the magnitude of the Josephson current seems to decrease with increasing degree of gapless superconductivity, its temperature and field dependences are very similar to those previously observed in superconductors displaying an energy gap. (auth)

7251 SUPERCONDUCTING TRANSITIONS OF ISOTOPES OF ZINC. Fassnacht, R. E.; Dillinger, J. R. (Univ. of Wisconsin, Madison). Phys. Rev., 164: 565-74(Dec. 10, 1967).

The effect of isotopic mass on the superconducting transition temperature T_c of Zn has been investigated in three highly purified samples with average isotopic masses of 63.96, 65.91, and 67.94. By extrapolating critical magnetic field curves to zero field, values of 0.855, 0.846, and 0.836°K were obtained for T_c of ^{64}Zn, ^{66}Zn, and ^{68}Zn, respectively. These values were found to satisfy the relation $T_c \propto M^{-z} = M^{-0.5(1-\zeta)}$ with z taken as 0.37 and ζ as 0.25. Critical field curves measured between 0.39°K and T_c were found to have a maximum deviation from a parabola of about 5.7%. Specific heats calculated from these critical field curves are compared with direct measurements made by others. The superconducting-to-normal transition of a sample was observed to broaden as the applied magnetic field was reduced below some small value. Ratios of transition widths in "zero" field and in the earth's field ranged from about 2 to over 30, depending on the sample. (auth)

7252 CONDITIONS FOR BOUND STATES IN A SUPERCONDUCTOR WITH A MAGNETIC IMPURITY. Fowler, Michael; Maki, Kazumi. (Univ. of Toronto). Phys. Rev., 164: 484-8 (Dec. 10, 1967).

Analytic continuation techniques recently developed for the normal-metal Kondo effect were used to examine the structure of Suhl's scattering amplitudes in a superconductor. It is found that there are no bound states (poles in the energy gap) unless the Kondo coupling is stronger than the Cooper pairing force, i.e., $T_K > T_{co}$. The positions of the bound-state poles are given as a function of coupling strength and temperature. The poles always stay on the real axis. (auth)

7253 DEGRADATION OF LONG-RANGE ORDER IN "ONE-DIMENSIONAL" SUPERCONDUCTORS. Groff, R. P.; Marcelja, S.; Masker, W. E.; Parks, R. D. (Univ. of Rochester, N. Y.). Phys. Rev. Lett., 19: 1328-33(Dec. 4, 1967).

The observed depression of T_c, as determined by resistivity measurements, and the anomalous critical-current behavior of superconducting microbridges are explained as resulting from fluctuations in the phase of the Ginzburg–Landau order parameter, leading to degradation of off-diagonal long-range order. (auth)

Plasma and Thermonuclear Physics

7254 (AED-C-03-13) DOCUMENTATION OF PLASMA PHYSICS. PART 1. EXPERIMENTAL PLASMA PHYSICS, THEORETICAL PLASMA PHYSICS. VOLUME 2. BIBLIOGRAPHY, AUTHOR INDEX, SUBJECT INDEX. (Institut fuer Plasmaphysik, G.m.b.H. Garching (West Germany)). Oct. 1967. 171p. Dep.

A listing of 315 articles on various aspects of plasma physics is presented. Subject and author indexes are included. (M.O.W.)

7255 EIGHTH INTERNATIONAL CONFERENCE ON PHENOMENA IN IONIZED GASES, VIENNA, AUSTRIA, AUGUST 27–SEPTEMBER 2, 1967. CONTRIBUTED PAPERS. Vienna, Springer-Verlag, 1967. 603p. (CONF-670810).

Copies of A Survey of Phenomena in Ionized Gases will be available in early 1968 at a price of $15.00 from International Atomic Energy Agency, Vienna.

Separate abstracts were prepared for the eleven included sections. (M.O.W.)

For abstracts of individual sections see: 7164, 7165, 7268, and 7306–7313.

Confinement and Heating of Plasma

Refer also to abstract 6523.

7256 (NP-16754) JAHRESBERICHT, 1965. (Annual Report, 1965). (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). 146p. (In German). Dep.

The Institute for Plasma Physics consists of three experimental divisions—theoretical, technical, and auxiliary services. The most important study of the first division was connected with the heating and containment of plasmas by fast magnetic compression in the theta pinch. The most progress was made in the introduction of the ISAR installation which consists of a fast energy accumulator of maximum 2.6 MJ. Using preionization by fast collision current along the axis of the discharge vessel (z pinch) it is possible to ignite plasmas of relatively low density and relatively high purity. At an energy of 1.5 MJ, ion temperatures up to 5.3 keV were obtained. The containment time was 10^{-5} sec and was limited by the loss from the end of the 1.5-m-long discharge vessel. A relative long displacement of the compressed plasma from the tube axis was observed, but there were no visible instabilities. Special emphasis was placed on the development of methods for measurement of physical properties of these plasmas. The scattered light method gave the best results; pulsed ruby lasers with power up to several 100 MV were used as light sources. By introduction of a multigap of glass fibers a simultaneous measurement could be made of seven ranges of the scattered light spectrum. At the temperatures and densities and the scattering angle used, the plasma electron no longer acts as an individual scatter, but correlation effects between the electrons begin to appear. The second division concentrated on toroidal containment. The behavior of cesium plasma, produced by contact ionization in an arrangement of the stellarator type and in an octupole torus, was studied. Studies have shown that the particles leave the space more rapidly than electrical conductivity calculations showed. The advantages of the alkali plasma produced by contact ionization were used in other studies in simple geometry to verify the plasma behavior and the plasma diagnostic methods. The properties of longitudinal plasma oscillation or Bernstein waves and that of the harmonics of the electron gyrofrequency were investigated. The possibilities and difficulties of the HELIOS project are intensively discussed. The work of the third division was concentrated on flowing stationary hydrogen plasmas of the arc type. Systematic measurements were made of the temperature, density, and velocity at the midpoint. Theoretical considerations were reported on the possibility of addition heating. The EIER UHR discharge group began with measurement of the potential distribution of the azimuthal current. The radial electron density distribution was determined by measurement of the Faraday rotation. Intensity measurements of the O V and O VI lines verified that the temperature maximum was over 200,000°. Studies on nonstationary collision waves with an interferometer and microwaves were completed; a detailed picture of the mechanism of this process is given. The work of the technical group with respect to high-voltage techniques, electronics, magnetic field technology, vacuum technology, and installation and construction is summarized. The publications of the Institute are compiled. (J.S.R.)

7257 AXIAL BEHAVIOR AND END LOSS OF PLASMA IN A SLOW THETA PINCH. Shiina, Shoichi (Nihon Univ., Tokyo). J. Phys. Soc. Jap., 23: 882-91(Oct. 1967).

The dynamic behavior of a helium plasma produced in a magnetic mirror field by a coil with large length and diameter was investigated with high-speed cameras and by spectroscopic observations. The produced plasma is unstable at the initial pressure above 50 mtorr, but is rather stable and drift-free at pressures below 25 mtorr. The plasma contracts axially to the midplane. The velocity of contraction is faster at higher pressure. After the maximum contraction the plasma expanded to the mirror plane with a velocity of about 2×10^6 cm/sec nearly independent of the initial pressure. During the expansion, the plasma decreases at the midplane and increases at the mirror plane. In the case of the drift-free plasma, the e-folding times of decreasing plasma at the midplane are 10 to 20 μsec increasing with decreasing initial pressure. These results show that the end loss of dense plasma from the mirror field is affected by a nonsteady axial plasma motion which seems to originate in the axially inhomogeneous distribution of the produced plasma. (auth)

7258 TURBULENT HEATING OF PLASMA. Zavoiskii, E. K.; Rudakov, L. I. At. Energ. (USSR), 23: 417-31(Nov. 1967). (In Russian).

Theoretical and experimental data are given on the regularity of electric current flow in plasma and on plasma heating in strong electric fields during pair collisions. The experiments confirmed the presence of low-scale plasma turbulence with high-level noises which resulted in abnormally high resistance and heating. The current instability and plasma turbulence are of high interest from the point of view of preparation of thermonuclear plasma. (R.V.J.)

7259 A COMPUTATION FOR STUDYING THE FORMATION OF THE RELATIVISTIC ELECTRON LAYER IN ASTRON. Killeen, John; Rompel, Shirley L. (Univ. of California, Livermore). Contract W-7405-eng-48. J. Comput. Phys., 1: 29-50 (Aug. 1966). (UCRL-14203-T).

In the controlled fusion experiment, Astron, relativistic electrons are injected into a cylindrical region containing an applied magnetic field. The object is to form the E layer, a cylindrical layer of electrons, so that the self-field exceeds the applied field. It is intended that the resulting configuration will be axially symmetric with no azimuthal component of magnetic field. The mathematical model for the buildup of the electron layer and self-field is the time-dependent Vlasov equation coupled with Maxwell's equations. The partial differential equations were solved numerically using finite-difference methods. The methods used are described in detail. The problem described is 4-dimensional and requires a large-scale computing system for the solution of the difference equations. A program of this type is meant to be used for extensive parameter studies. In particular, the form of the applied fields can be varied, as well as the method of injection. There is a great variety of quantities that can be printed out or plotted at any given time step. A sample is given of displayed output of some results for a convenient form of the vacuum field and a simple mode of injection. (BBB)

7260 PLASMA CONFINEMENT IN THE TOROIDAL MULTIPOLE. Ohkawa, Tihiro; Rostoker, Norman. Phys. Today, 20: No. 12, 49-55(Dec. 1967).

A brief review of present attempts to confine a thermonuclear plasma is given. Advantages of a toroidal multipole device for confinement are discussed. (M.O.W.)

7261 CLOSED MAGNETIC TRAP WITH SPIRAL FIELD: "SIRIUS". Biryukov, O. V.; Burchenko, P. Ya.; Vasilenko,

B. T.; Volkov, E. D.; Georgievskii, A. V.; Loginov, A. S.; Nikolaev, R. M.; Sashenko, Yu. V.; Suprunenko, V. A.; Tolok, V. T. At. Energ. (USSR), 23: 99-102(Aug. 1967). (In Russian).

The closed magnetic trap with combined fields for investigation of confinement and introduction of high-temperature plasmas is described. The maximum confining magnetic field of the trap is $H_0 = 20$ kOe, the diameter of the vacuum chamber is 10 cm, the radius of the toroidal region is 60 cm, $\beta_{equi} \approx 0.008$, and the limiting Shafranov–Kruskal current is 4 kA. The principal confining field is constructed by a system of multiturn coils. The crimping of the longitudinal field $\Delta H_0/H_0$ along the axis of the system is 1.6%, and the transverse components of the field for the supply lead do not exceed 0.01% H_0. In the curved region of the chamber, two three-turn spiral windings with "cylinders" on the terminal are arranged. As the supply source of the magnetic system, a condenser battery of 0.144 F is used. It can store energies of 1.8 MJ. The voltage is 5 kV. Special means of protection for safe operation of the battery are provided. The limiting vacuum of the stellarator chamber, obtained after some cycles of heating at temperature of 450°C is 4×10^{-10} mm Hg. The characteristics of the equipment used for production and heating of the plasma are given. The use of some methods of adjustment of the magnetic field systems make it possible to make very fine alignments. The results of the calculation of the deflection angle and the coil location agrees well with the results of the system alignment. (tr-auth)

Diagnostics of Plasma

7262 STARK BROADENING OF He II 3203 A. Ando, Kozo (Inst. of Physical and Chemical Research, Tokyo). J. Phys. Soc. Jap., 23: 1183(Nov. 1967).

Measurements of the profile of the He^+ 3203 Å line were carried out on a magnetically confined He arc plasma at a pressure of about 10^{-4} torr of ambient neutral gas. The wing theory of Griem was used to calculate the electron density from these results. The electron density was found to be 7.9×10^{13} electrons/cm^3. Another measurement of electron density with a 2-mm-microwave interferometer gave 9.5×10^{13} electrons/cm^3 under the same conditions. (A.G.W.)

7263 PROFILE OF SHOCK WAVE PLASMA MEASURED BY LASER LIGHT SCATTERING. Izawa, Yasukazu; Nakanishi, Yoshichiro; Yokoyama, Masahiro; Yamanaka, Chiyoe (Osaka Univ.). J. Phys. Soc. Jap., 23: 1185-6(Nov. 1967).

A laser-light-scattering method was used to determine electron density and temperature of a shock-wave plasma as a function of time from 10 to 50 μsec after the arrival of the shock front. Typical spectral distributions of the scattered light are shown. The measured electron density is in good agreement with that estimated from the Rankine–Hugoniot relations. (A.G.W.)

7264 EQUIVALENT CIRCUIT OF FULLY IONIZED PLASMAS. Poularikas, A. D. (Univ. of Rhode Island, Kingston); McCutcheon, M. J. J. Appl. Phys., 38: 5415-16(Dec. 1967).

The relationships between the parameters of a conducting gas in applied electric and magnetic fields with those of a lumped electrical analog have been considered by several authors, e.g., Alfvén. In this paper an attempt is made to take into consideration the effects of an arbitrary angle between the electric and magnetic fields. (W.D.M.)

7265 OPTICAL DETERMINATION OF Cs GROUND-STATE DEPLETION IN Cs–Ar LOW-PRESSURE DC DISCHARGES. Bleekrode, R. (Philips Research Labs., Eindhoven, Netherlands). J. Appl. Phys., 38: 5062-5(Dec. 1967).

The results of an experimental study of the absorption properties of Cs as present in Cs–Ar low-pressure discharges under various discharge conditions are presented. The total Cs concentration at zero discharge current was varied between 1.5 and 15×10^{12} cm^{-3}. Absorption was measured in the 4555-Å and 8521-Å lines of Cs from which the stationary concentration of Cs($6^2S_{\frac{1}{2}}$) could be derived. Special attention was paid to determine the Cs concentration as the discharge changed from a low-burning voltage mode to a high-burning voltage mode. The pronounced variations of the discharge properties were found to be accompanied by rather drastic changes of the Cs concentration for which variations of a factor of ten or more were found. (auth)

7266 DIAGNOSTICS BY MACH–ZEHNDER INTERFEROMETRY OF A PLASMA PRODUCED BY LASER IRRADIATION OF THIN FOILS. Bruneteau, J.; Fabre, E.; Lamain, H.; Vasseur, P. (Ecole Polytechnique, Paris). Phys. Lett., 26A: 37-8(Dec. 4, 1967). (In French).

Measurements of the density distribution in a plasma produced by laser irradiation of a thin foil are made by optical Mach–Zehnder interferometry. (auth)

7267 SIMPLE METHOD FOR MEASUREMENT OF dc CURRENTS OF FLOATING POTENTIALS. Wiesemann, K. (Univ., Marburg, Ger.). Z. Angew. Phys., 23: 454-6(Nov. 14, 1967). (In German).

Measurements of low dc currents (greater than 0.5 nA) on floating potential are possible with a nonlinear resistor as current sensor whose second derivative of the dc-characteristic is proportional to the current itself. By using an ac method to measure the second derivative it is possible to isolate the measuring device from the current sensing resistor by transformers. The method is useful for probe measurements in plasmas. (auth)

7268 DIAGNOSTIC TECHNIQUES. pp 477-534 of Eighth International Conference on Phenomena in Ionized Gases, Vienna, Austria, August 27–September 2, 1967. Vienna, Springer-Verlag, 1967.

See CONF-670810.

Fifty-eight papers are presented on the following subjects: (1) probe techniques, (2) probe characteristics, (3) microwave and rf propagation techniques, (4) microwave and rf probe techniques, (5) spectral line techniques, (6) laser techniques, (7) beam probing, (8) electromagnetic wave scattering, and (9) other diagnostic methods. (M.O.W.)

7269 COMMENT ON THE USE OF LANGMUIR PROBES FOR LOW-DENSITY PLASMA DIAGNOSTICS. Garscadden, A.; Palmer, R. S. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Amer. J. Phys., 35: 1093-4(Nov. 1967).

The purpose of this communication is to suggest an explanation for the anomalously high value of ion density found by Mawardi in a recent article (Am. J. Phys., 34: 112(1966)). It appears to have been obtained because Mawardi neglected the influence of the electron temperature on the ion-current collection at high negative-probe potentials, or alternatively, he has used the Pangmuir theory under inappropriate conditions. (W.D.M.)

7270 STARK BROADENING OF ARGON I SPECTRAL LINES IN AN ARC PLASMA. Schulz, P.; Wende, B. (Univ., Karlsruhe. Physikalisch-Technische Bundesanstalt, Brunswick and Berlin). Z. Phys., 208: 116-28(1968). (In German).

The Stark broadening of Ar I spectral lines characterized by quadratic Stark effect was investigated in a wall-stabilized argon arc plasma. Only in some cases the theoretical interruption broadening half widths according to Weisskopf–Unsöld–Lindholm agree with the experimental values, usually they are smaller up to the factor 0.44. On the other side the Stark half widths calculated by the new Griem method are higher than the experimental values, however, mostly they are in the experimental limit of error. (auth)

7271 ELECTRON DENSITY MEASUREMENTS DURING A CURRENT PERTURBATION OF A WALL STABILIZED ARGON ARC. Hearne, K. R.; Konjevic, N. (Liverpool Univ.). Z. Phys., 208: No. 1, 65-72(1968).

The application of a laser interferometric technique to the measurement of electron density changes which occur when a dc argon arc is subjected to a current step or ac modulation is described. The frequency of the latter was varied from 50 to 30,000 Hz. A first attempt is made to derive mobility measurements from the data. (auth)

7272 SPECTROSCOPIC MEASUREMENTS OF VELOCITY PROFILES AND NON-EQUILIBRIUM RADIAL TEMPERATURES IN AN ARGON PLASMA JET. Bohn, W. L.; Beth, M.-U.; Nedder, G. (DVL-Institut fuer Plasmadynamik, Stuttgart). J. Quant. Spectrosc. Radiation Transfer, 7: 661-76(July-Aug. 1967).

Radial temperature and velocity profiles of an argon plasma jet (1.5 torr) were investigated experimentally at distances of 2, 10, and 18 cm from the nozzle exit. By measuring Doppler shifts and Doppler half widths of spectral lines with a Fabry–Perot interferometer, velocities and temperatures of heavy particles were determined. The electron temperatures were computed from absolute line intensities by applying a special nonequilibrium ionization equation. Measured integrated values were reduced to radial profiles by using appropriate inversion formulas. Results are shown in numerous diagrams. The velocity profiles flatten with increasing distance from the nozzle exit, while the velocity along the axis decreases from 3 to 1.5 km/sec. The profiles of electron temperature behave in the same way as velocity profiles, while the electron temperature, which is at about 10,000°K on the axis, decreases very slowly. Temperatures of heavy particles are about one third of the electron temperature on the axis and show flat profiles and a tendency to rise as the distance from the nozzle exit increases. (auth) (UK)

7273 DIRECT DISPLAY OF ELECTRON TEMPERATURE VARIATION IN MOVING STRIATIONS. Drouet, M. G. (Univ. of Montreal). J. Sci. Instrum., 44: 1023-4(Dec. 1967).

Two Langmuir probes were used successfully to obtain direct

oscillographic display of the electron temperature variations in moving striations in an argon positive column. The technique used is discussed and sample measurements are presented. (auth) (UK)

Kinetics of Plasma

Refer also to abstract 7086.

7274 (MATT-555) IONOSPHERE THOMSON SCATTER AS A MEANS TO STUDY PLASMA WAVES PROPAGATING ALMOST PERPENDICULAR TO A MAGNETIC FIELD. Perkins, F. W. (Princeton Univ., N. J. Plasma Physics Lab.). Aug. 1967. Contract AT(30-1)-1238. 25p. Dep. CFSTI.

The possibility of studying electrostatic waves in a warm plasma by radar Thomson scatter from the ionosphere is discussed. The first experiment involves studying the multiple roots of the plasma wave dispersion relation in the region $\omega_p^2 = 4\pi ne^2/m > \omega_c^2 = (eB/mc)^2$ with the 1300 Mc/sec radars ($\lambda = 23$ cm) located at the Stanford Research Institute and at Lincoln Laboratory. For these radars the parameter $b = q^2KT/m\omega_c^2$ is close to unity and the presence of multiple roots is important. (Here $T \sim 10^3$°K is the ambient electron temperature and $q = 4\pi/\lambda$ is the wave vector associated with backscatter geometry when the radar wavelength is λ.) The experiment would be to observe scattering at two different frequency shifts from the same region of the ionosphere. The second experiment is the observation of scattered power with frequency shifts in the neighborhood of the lower hybrid resonance at the Jicamarca Radar Observatory. This component of the Thomson scatter spectrum has not yet been observed, and would be a means to monitor the presence of photoelectrons in the magnetosphere above the magnetic equator. The frequency of the lower hybrid resonance is strongly affected by small concentrations of lighter ions and would provide data regarding the ionic composition in the ionosphere and magnetosphere. (M.O.W.)

7275 (MATT-Trans-43) EXCITATION OF THE FAST MAGNETOACOUSTIC WAVE IN THE STELLARATOR PLASMA. Burchenko, P. Ya.; Vasilenko, B. T.; Volkov, E. D.; Longinov, A. V.; Nikolaev, R. M.; Potapenko, V. A.; Frolov, V. A. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated for Princeton Univ., N. J. from report FTI-289/P-103. 9p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Investigations were made on the excitation of fast magnetoacoustic waves in stellarator plasma in the frequency range of $\omega_{ce} \gg \omega \gg \omega_{ci}$ and $\Omega_e \gg \omega_{ce}$ (ω_{ce}, ω_{ci} are the cyclotron frequencies of the electrons and ions, Ω_e is the Langmuir electron frequency. (M.O.W.)

7276 (UCRL-Trans-10149) CURRENT-CONVECTIVE INSTABILITY OF AN ELECTRON BEAM IN PLASMA. Rayzer, M. D.; Rukhadze, A. A.; Strelkov, P. S. Translated by T. Watt for Univ. of California Lawrence Radiation Lab., Livermore, from Report No. 99. 28p. Dep. CFSTI. JCL $2.60 fs, $1.07 mf.

A study was made of the propagation of an electron beam through plasma produced by the beam itself in a uniform magnetic field. It is shown that under certain conditions the process can be divided into two stages, i.e., a stable and an unstable stage. Transition to the unstable stage appears as a rapid reduction in the collector current and is accompanied by an increase in the plasma density and the emission of high-intensity microwave radiation. An experimental study was also made of the duration of the stable stage as a function of the initial gas pressure, electron-beam density, length of the system and magnetic-field strength. It was found that the magnetic field had a stabilizing effect. Numerical estimates are reported of the current-convective instability during the interaction of the beam with the electron component of the plasma. The principal experimental results are in good qualitative agreement with theoretical predictions. (auth)

7277 COMPUTER EXPERIMENT ON FERRARO–ROSENBLUTH PROBLEM. Hasegawa, Akira; Okuda, Hideo (Osaka Univ.). J. Phys. Soc. Jap., 23: 906(Oct. 1967).

The Ferraro–Rosenbluth problem, which is concerned with the boundary layer between a magnetic field and a transversely injected plasma, is studied using a sheet plasma model. The preliminary results are reported. (M.O.W.)

7278 RESONANT RESISTIVE INSTABILITY AND ASSOCIATED HEATING OF ELECTRONS IN BEAM–PLASMA SYSTEM. Hasegawa, Akira (Osaka Univ.). J. Phys. Soc. Jap., 23: 909-10(Oct. 1967).

A new instability is described which is a possible cause of hot electron production in a beam–plasma system. (M.O.W.)

7279 DESIGN OF INDUCTIVELY COUPLED PLASMA. Armstrong, D. R.; Ranz, W. E. (Univ. of Minnesota, Minneapolis). Ind. Eng. Chem., Process Design Develop., 7: 31-4(Jan. 1968).

A design model based on energy balance considerations was developed for an induction-coupled plasma which can be used for high-temperature chemical reactions. The model accounts for three mechanisms of energy transfer, an induction energy input, and two heat loss rates, one involving radiation and the other conduction and convection. Some experimental confirmation of the model using a system operating at frequencies from 15 to 28 MHz and plasma diameters from 0.8 to 1.6 cm is included. (auth)

7280 ENTRANCE HEAT TRANSFER FROM A PLASMA STREAM IN A CIRCULAR TUBE. Johnson, J. R.; Choksi, N. M.; Eubank, P. T. (Texas A and M Univ., College Station). Ind. Eng. Chem., Process Design Develop., 7: 34-41(Jan. 1968).

Experimental values of the Nusselt number were measured and empirically correlated for entrance section heat transfer from a confined plasma jet of three gases—helium, argon, and nitrogen—flowing in a circular tube. The approximate upper limit of Reynolds number was 900 and temperature level was 7000°K. Heat transfer coefficients were higher than in previous investigations because the plasma enters the tube from a nozzle of smaller diameter causing recirculation near the tube wall. The present correlation is compared with empirical equations for warm gases at subplasma temperatures, boundary layer theory predictions, and the plasma correlation of Skrivan and von Jaskowsky. The "hot plasma core" model is discussed in respect to photographs of the plasma jet for each of the three gases. (auth)

7281 EVOLUTION OF A NONLINEAR ION ACOUSTIC WAVE. Montgomery, David (Univ. of Iowa, Iowa City). Phys. Rev. Lett., 19: 1465-6(Dec. 25, 1967).

The evolution of a nonlinear ion acoustic wave in a Vlasov plasma with the electron temperature much larger than the ion temperature is reported. A two-fluid model is used in the analysis. (M.O.W.)

7282 POTENTIAL DISTRIBUTION IN A MAGNETIZED COLD PLASMA. Mori, Ichiro (Osaka Univ.). J. Phys. Soc. Jap., 23: 1114-21(Nov. 1967).

The effect of an electric field on the diffusion of a plasma across a magnetic field was analytically investigated for the purpose of calculating the power generation from the potential energy. The results are compared with experiment. The friction and the diffusion coefficient were obtained as a function of the electric field caused by the diffusion of the ions. It was found that, in the direction of the electric field, the diffusion increases while it decreases in the opposite direction. A measurement of potential distribution and plasma density in a cylindrical plasma produced by an electron beam was performed; the results agree qualitatively with the theory. (auth)

7283 COLLISION-INDUCED INSTABILITIES NEAR ELECTRON CYCLOTRON HARMONICS IN PLASMA. Idehara, Toshitaka; Sugaya, Reiji (Univ. of Kyoto). J. Phys. Soc. Jap., 23: 1122-31(Nov. 1967).

Instabilities of longitudinal waves and transverse waves in plasma are discussed by using the Boltzmann equation containing a collision term between an electron and massive particles. It is assumed that the plasma is homogeneous and the unperturbed distribution function in velocity space f_0 is δ-functional, i.e., $f_0 \propto \delta(v - v_\phi)$, and the collision frequency ν varies as $\nu \propto v^h$. In the case of the propagation perpendicular to the magnetic field, a collision-induced instability occurs near electron cyclotron harmonics ($\omega \approx n\omega_c$) when the condition $h > N$ is satisfied, where $N = 2n + 1$ for extraordinary waves and $N = 2n + 3$ for ordinary waves, and the maximum growth rate $(\omega_i)_{max}$ is equal to $\{(h-N)/N\}\nu$ for both waves. (auth)

7284 NONLINEAR HYDROMAGNETIC SOLITARY WAVES IN A COLLISION-FREE PLASMA WITH ISOTHERMAL ELECTRON PRESSURE. Kakutani, Tsunehiko (Univ. of Kyoto); Kawahara, Takuji; Taniuti, Tosiya. J. Phys. Soc. Jap., 23: 1138-49(Nov. 1967).

Nonlinear hydromagnetic solitary waves propagating in a collision-free plasma of cold ions and isothermal electrons are investigated on the basis of hydrodynamic transport equations. Cases of wave propagation along and across a magnetic field are studied in detail. In the parallel case, two types of solitary waves are found. The first type is an ordinary one, which reduces to the zero-pressure wave in the cold limit, and the other is a particular one, which has no counterpart in the cold plasma. In the transverse case, only one type of solitary wave similar to that in the cold plasma is found. The effect of electron pressure

shortens the relative widths of the waves in the parallel case (for the first type) while it widens those in the transverse case. Magneto-ion dynamics is formulated for the plasma under consideration, where the relation between the two-fluid model and the one-fluid magnetohydrodynamics is established. (auth)

7285 PARAMETRIC EXCITATION OF ION WAVES. Yoseli, Morihiro (Electrotechnical Lab., Tokyo). J. Phys. Soc. Jap., 23: 1150-6(Nov. 1967).

The parametric excitation of ion waves in a weakly ionized plasma is theoretically studied when the incident pumping electric field modulates the electron drift velocity, the plasma density, and the electron temperature. The linearized hydrodynamic equations are solved in the one-dimensional case and are reduced to a type of Mathieu equation. This theory explains qualitatively the experiments of the parametric excitation of the ion plasma oscillation in a weakly ionized plasma; it is concluded that in this case the effect of the modulation of the plasma density on the parametric resonance is large compared with the effect due to the modulation of the electron drift velocity and the electron temperature. (auth)

7286 BEAM/PLASMA INTERACTION WITH TRANSVERSE MODULATION. Abraham, E. E.; Crawford, F. W.; Mills, D. M. (Stanford Univ., Calif.). pp 470-4 of Microwave and Optical Generation Amplification. IEE Conference Publication 27. London, The Institution of Electrical Engineers, 1967.

From 6th International Conference on Microwave, Optical Generation, and Amplification, Cambridge, Eng., Sept. 12–16, 1966. See CONF-660932.

Computations are presented for a finite beam in a finite plasma, indicating that the predicted growth rates for axisymmetric and transverse modulation are generally comparable. Some conclusive observations of growth in the transverse mode are described. (M.O.W.)

7287 ATTENUATION AND COUPLING IMPEDANCE OF THE BACKWARD DIPOLE SURFACE WAVE ON A CYLINDRICAL PLASMA COLUMN. Gregory, B. C. (CSF-CEPEC, Orsay, France). pp 475-9 of Microwave and Optical Generation Amplification. IEE Conference Publication 27. London, The Institution of Electrical Engineers, 1967.

From 6th International Conference on Microwave, Optical Generation, and Amplification, Cambridge, Eng., Sept. 12–16, 1966. See CONF-660932.

The attenuation constant of the dipole surface wave has been measured and compared with theoretical calculations. Approximate agreement is obtained for its values and for the form of its variation as a function of $\omega^2/(\omega_p^2)$. The coupling impedance of the mode to a solid electron beam has been calculated and is such that the concept of a plasma B.W.O. is possible. (auth)

7288 PARAMETRIC AMPLIFICATION IN A BEAM–PLASMA SYSTEM. Pham-Tu-Manh (Faculte des Sciences, Orsay, France). pp 485-9 of Microwave and Optical Generation Amplification. IEE Conference Publication 27. London, The Institution of Electrical Engineers, 1967. (In French).

From 6th International Conference on Microwave, Optical Generation, and Amplification, Cambridge, Eng., Sept. 12–16, 1966. See CONF-660932.

An experiment is described from which positive results are obtained for amplification by the parametric effect in a beam–plasma system. The plasma is formed by ionization of a neutral gas, either argon or xenon at a pressure between 10^{-4} and 10^{-2} torr, by an electron beam inside a metallic cylindrical cavity. A system of very distinct stationary waves is observed, and a signal amplification is found. The gain is shown versus the pump power and frequency and versus the signal power and frequency. There is also an idler signal which grows with the pump power at the same time as the signal. (J.F.P.)

7289 NONLINEAR BEHAVIOR AND FREQUENCY MIXING IN A PLASMA OF AN AUTO-OSCILLATING PIG DISCHARGE WITH COLD CATHODES. Andre, Bouchoule; Samuel, Bliman; Martinez, M. (Faculte des Sciences, Orsay, France). pp 490-4 of Microwave and Optical Generation Amplification. IEE Conference Publication 27. London, The Institution of Electrical Engineers, 1967. (In French).

From 6th International Conference on Microwave, Optical Generation, and Amplification, Cambridge, Eng., Sept. 12–16, 1966. See CONF-660932.

From the experiments using a reflex discharge with cold cathodes, nonlinear effects are found in an auto-oscillating PIG discharge. For certain regions of operation a system of distinct oscillations is obtained, having a line frequency spectrum. The observed oscillations are attributed to the instability from the interaction of primary electrons emitted by the cathodes with the stationary discharge plasma. Under certain conditions various nonlinear effects are observed. High-frequency wave interactions are also studied. These waves are injected into the PIG column. The spectra of clearly visible frequencies are analyzed. It is determined that the nonlinear mechanism must not be of a type analogous to the previously described crossed modulation. For one thing, the collision frequencies are less than those used, and for another, frequency differences are observed in even and odd harmonics. (J.F.P.)

7290 OSCILLATIONS IN A BEAM GENERATED PLASMA. Bogdanov, E. V.; Zalogin, N. N.; Kislov, V. Ya. pp 495-508 of Microwave and Optical Generation Amplification. IEE Conference Publication 27. London, The Institution of Electrical Engineers, 1967.

From 6th International Conference on Microwave, Optical Generation, and Amplification, Cambridge, Eng., Sept. 12–16, 1966. See CONF-660932.

Microwave and low-frequency oscillations are discussed. (M.O.W.)

7291 PLASMA FILLED CAVITY AS A COUPLER FOR BEAM PLASMA AMPLIFIERS. Biechler, C. S.; Chorney, P. (Microwave Associates, Inc., Burlington, Mass.). pp 515-19 of Microwave and Optical Generation Amplification. IEE Conference Publication 27. London, The Institution of Electrical Engineers, 1967.

From 6th International Conference on Microwave, Optical Generation, and Amplification, Cambridge, Eng., Sept. 12–16, 1966. See CONF-660932.

Calculations are presented which indicate that a cavity filled with a Penning discharge could be used as a coupler to beam–plasma amplifiers. (M.O.W.)

7292 RESONANCE-RECTIFICATION EFFECTS IN WARM MAGNETOPLASMAS. Crawford, F. W.; Harp, R. S.; Mantei, T. D. (Stanford Univ., Calif.). J. Appl. Phys., 38: 5077-82 (Dec. 1967).

The study of resonance-rectification phenomena in plasmas is extended to the case where a static magnetic field is present. Parallel wire-probe geometry was chosen so that the rf electric field is primarily perpendicular to the magnetic field. Under these conditions, experiments show that there are two distinct series of resonance peaks, one occurring between successive cyclotron harmonics, the other precisely at the cyclotron harmonics. Cold-plasma theory is inadequate to account for the existence of these resonances. An explanation is proposed, based on the form of the warm-plasma permittivity component perpendicular to the magnetic field, which explains satisfactorily all of the experimental observations. (auth)

7293 WAVE PROPAGATION IN A BEAM–PLASMA SYSTEM. Bliman, Samuel; Bouchoule, Andre (CNRS, Orsay, France). J. Appl. Phys., 38: 5065-76(Dec. 1967).

A nonquasistatic treatment is established in order to study wave propagation along beam–plasma systems in the presence of a dc magnetic field. Solutions to the dispersion equations are given for two cases: The column completely fills a cylindrical waveguide, or it is in an infinite dielectric (vacuum). The results are compared qualitatively to those already obtained by various authors for the same conditions by a quasistatic analysis. (auth)

7294 EXPERIMENTAL VERIFICATION OF LANDAU WAVES IN AN ISOTROPIC ELECTRON PLASMA. Derfler, Heinrich; Simonen, Thomas C. (Stanford Univ., Calif.). J. Appl. Phys., 38: 5014-20(Dec. 1967).

Measurements are reported of dispersion and damping of plane electrostatic waves having phase velocities between 1.5 and 3 times electron thermal speed 3×10^7 cm/sec. These waves were excited and detected at frequencies $\omega_p < \omega < 2.5\omega_p$ using gridded rf probes within an isotropic, quiescent, and collision-free sodium plasma at thermal equilibrium. As plasma electron density (1×10^7 to 2×10^8 cm^{-3}) and rf (30 to 180 MHz) are varied, the measured wavelengths and spatial damping rates were scaled to Debye length using independent Langmuir probe data. Full agreement is then found between the experimental results and the fundamental solution of Landau's dispersion relation. (auth)

7295 THEORY OF PLASMA TRANSCONDUCTANCE DUE TO LANDAU WAVES. Derfler, Heinrich; Simonen, Thomas C. (Stanford Univ., Calif.). J. Appl. Phys., 38: 5005-13(Dec. 1967).

An N-pole circuit analysis of a network of parallel plane grids immersed in an isotropic hot-electron plasma is presented. The associated self- and trans-impedances are expressed in terms of the discrete spectrum of electrostatic waves. Voltage-transfer ratios and transconductances between pairs of grid assemblies are calculated to study the feasibility of this scheme for launching and detecting Landau waves. Results show that widths of about 5 Debye

lengths are optimum for modulator and detector gaps and that close-range transmission between gaps is predominantly due to the fundamental exponentially damped Landau wave. (auth)

7296 EFFECT OF THE MOTION OF A STRONGLY MAGNETIZED PLASMA ON THE EMISSION OF RADIATION BY A FINITE DIPOLE. McKenzie, J. F. (Ames Research Center, Moffett Field, Calif.). J. Appl. Phys., 38: 5249-55(Dec. 1967).

The effect of the motion of a strongly magnetized and cold plasma on the propagation and radiation of electromagnetic waves is considered. The radiation loss suffered by a finite dipole situated in a moving plasma is calculated. It is shown that when the dipole frequency exceeds the plasma frequency, the total radiation emitted by the dipole can be enhanced by several orders of magnitude by a slowly moving plasma. The radiation output can also be enhanced when the dipole frequency is less than the plasma frequency, particularly at relativistic speeds, provided the scale length of the dipole is sufficiently large. (auth)

7297 SIMILARITY PRINCIPLE FOR MULTIPACTING DISCHARGES. Woo, Richard (California Inst. of Tech., Pasadena, Calif.); Ishimaru, Akira. Contract NAS7-100. J. Appl. Phys., 38: 5240-4(Dec. 1967).

A similarity principle is introduced for multipacting discharges in geometrically similar electrode configurations. For phase-similar breakdowns, it is shown that the rf and dc voltages are proportional to $(fl)^2$, the electron velocity is proportional to fl, and the rf and dc magnetic fields are proportional to f, where f is the frequency of the rf voltage and l is the characteristic length for similar configurations. If the electron kinetic energy is similar as well, fl must also be invariant. These similarity relations are applied to previous work in parallel plates, and it is shown that the results of the different multipacting cases can be unified under the similarity principle. A physical explanation is also given for the success of the constant v_f/v_i assumption, where v_i and v_f are the respective emission and impact electron velocities. When applied to geometries other than parallel plates, the similarity principle yields important scaling information and allows prediction of the breakdown behavior in these geometries, where analytical solutions are otherwise not available. (auth)

7298 CURRENT DISTRIBUTION IN NONEQUILIBRIUM J x B DEVICES. Argyropoulos, G. S.; Demetriades, S. T.; Kendig, A. P. (STD Research Corp., Pasadena, Calif.). J. Appl. Phys., 38: 5233-9(Dec. 1967).

The interdependent problems of determining the current density field and the electron temperature and number density profiles in nonequilibrium $J \times B$ devices are formulated realistically, and solved numerically. The two-dimensional formulation includes the important effects of thermal and concentration diffusion, thermal and velocity boundary layers, and finite reaction rates on the electrical behavior of crossed-field devices, and allows each effect to be studied separately. As a result, this study predicts and interprets the asymmetry of the current distribution that has often been reported in experimental studies. Computations in potassium-seeded nitrogen plasmas have shown that streamwise nonuniformities can be very pronounced both in the core and in the electrode boundary regions of high-current density devices. In the limiting case of instantaneous reaction rates (ionization equilibrium at the electron temperature) and instantaneous energy relaxation, current lines in the core display a striking increase in slope throughout the narrow region between the insulator segments, where they become almost perpendicular to the flow direction and much denser than in the remaining part of the core. Under these conditions, there is no evidence of current "shorting" through the boundary layer, although the T_e distribution is such that high-luminosity regions appear over the electrodes, particularly over the cathode. The general and flexible methods developed in this study allow realistic evaluation of suggested designs under various operating conditions. (auth)

7299 EFFECTS OF AN EXTERNAL MAGNETIC FIELD ON LANDAU DAMPING IN MAXWELLIAN PLASMAS. Babler, Gary M.; Willett, Joseph E. (Univ. of Missouri, Columbia). J. Appl. Phys., 38: 5217-32(Dec. 1967).

Landau damping of longitudinal electron oscillations in a boundless, Maxwellian, collisionless magnetoplasma is studied in an approximation which neglects the coupling to transverse oscillations. The longitudinal component of the electric field is explicitly developed as a superposition of exponentially damped sinusoidal oscillations for an initial perturbation sinusoidal in space and Maxwellian in velocity. A formula is derived for the minimum time for Landau damping, i.e., the time which must elapse before only the lowest frequency oscillation is significant. An analysis is presented for the strong magnetic field case in which $\omega_c \gg 2\pi|\sin\theta|\,(\lambda/\lambda_D)\omega_p$, where ω_c is the cyclotron frequency, θ is the angle between the propagation vector and the external magnetic, λ_D is the Debye length, λ is the wavelength, and ω_p is the plasma frequency. For this case the Landau zeros move continuously along rays from their location in the absence of a magnetic field when the angle θ is zero to the origin as this angle approaches 90 deg. With this same variation of angle the minimum time increases from the null field value to infinity. These results are independent of the cyclotron frequency, provided that the above inequality is satisfied. For no external magnetic field the minimum time is found to increase with increasing wavelength and decreasing thermal spread of the initial perturbation when the spread is less than that of the unperturbed distribution. (auth)

7300 INFLUENCE OF DIFFUSION ON THE TOWNSEND DISCHARGE IN A UNIFORM ELECTRIC FIELD. Burch, D. S.; Huxley, L. G. H. (Australian National Univ., Canberra). Aust. J. Phys., 20: 625-31(Dec. 1967).

An analysis is presented to elucidate the role of diffusion in a Townsend discharge between plane parallel electrodes. Spatial independence of the electron energy distribution function is postulated, and the development proceeds by solution of the appropriate continuity equations. It is shown that experiment may be expected to verify Townsend's law in all but extreme cases, but that diffusion corrections must be applied if measured values of the primary ionization coefficient α_T are to be used for determination of quantities such as the ionizing collision frequency. Further, Paschen's law is demonstrated to be unaffected by effects resulting from diffusion. (auth)

7301 DRIFT WAVES OF FINITE AMPLITUDE. Pomeau, Y. (Laboratoire de Physique des Plasmas, Orsay, France). Phys. Lett., 26A: 34-5(Dec. 4, 1967). (In French).

It is shown that the one-dimensional drift wave with finite amplitude is a solution of the Korteweg–de Vries equation. This equation is written down for the cases $T_i = T_e$ and $T_i \ll T_e$. (auth)

7302 SELF-CONSISTENT ASTRON E LAYER WITH SPREAD IN ENERGY AND ANGULAR MOMENTUM. Sestero, A.; Zannetti, M. (EURATOM–CNEN, Rome). Phys. Rev. Lett., 19: 1377-9(Dec. 11, 1967).

The computation of a self-consistent Astron-type E layer (uniform and unbounded in the axial direction) is briefly outlined and illustrated with some examples, with and without velocity spread in the electron distribution. The calculation is based on the explicit integration of the (relativistic) Vlasov equation for the electrons in terms of the (single-particle) constants of the motion. (auth)

7303 EXCITATION OF LOWER HYBRID OSCILLATIONS AT UPPER HYBRID RESONANCE BY MICROWAVES. Hiroe, S.; Ikegami, H. (Nagoya Univ., Japan). Phys. Rev. Lett., 19: 1414-16(Dec. 18, 1967).

The possible observation of lower hybrid oscillations excited by microwaves in the presence of a dc magnetic field is reported. (M.O.W.)

7304 DISPERSION OF SURFACE PLASMA LOSSES OF CLEAN AND OXIDIZED ALUMINIUM SURFACES. Kloos, T. (Univ., Hamburg). Z. Phys., 208: No. 1, 77-93(1968). (In German).

Plasma oscillations were excited by 34-kV electrons in thin foils of aluminum vaporized on foils of Al_2O_3 in ultra-high vacuum. It was thus possible to investigate oscillations of clean and oxidized Al surfaces. By measurements of the energy loss as a function of the scattering angle of the exciting electrons both effects of dispersion could be demonstrated in good agreement with the theory. Also the influence of retardation was observed. The dispersion of the surface plasma oscillations is caused by (1) the coupling of the two surfaces of thin foils, that leads to a splitting into two modes of oscillation with different dependence of frequency on wavelength, and (2) the influence of thin coating, e.g. oxide, that produces a displacement of the frequency depending on the wavelength of the surface oscillation. (auth)

7305 REMARKS ON THE STATIC THEORY OF OSCILLATIONS OF A RELATIVISTIC PLASMA IN A UNIFORM MAGNETIC FIELD. I. Draganu, Mircea Mathematica, 7: 211-32(1965). (In French).

A relativistic generalization of the method developed by Gross, Sitenko, and Stepanov with a view to analyzing small oscillations of a plasma in an applied magnetic field is given. Comparison is also made with Harris' corresponding relativistic generalization method. The considerations differ essentially from those of Imre and Buti not only in the method of mathematical analysis used, but also in the deduction of various more general relationships. (IAA)

7306 COLLISION PROCESSES IN SWARMS. pp 1-28 of Eighth International Conference on Phenomena in Ionized Gases,

Vienna, Austria, August 27–September 2, 1967. Vienna, Springer-Verlag, 1967.
See CONF-670810.

Twenty-eight papers are included on the following subjects: (1) recombination, (2) mobility, diffusion, and reactions, (3) electron collisions and attachment and detachment, and (4) ionization and dissociation. (M.O.W.)

7307 LOW-PRESSURE DISCHARGES. pp 72-190 of Eighth International Conference on Phenomena in Ionized Gases, Vienna, Austria, August 27–September 2, 1967. Vienna, Springer-Verlag, 1967.
See CONF-670810.

One hundred and nineteen papers are included on the following subjects: (1) breakdown and pulsed discharges, (2) arcs (cathode and surface phenomena), (3) hollow cathodes, (4) positive columns I, (5) positive columns II, (6) glow discharges (anomalous effects), (7) moving striations and constructions, (8) instabilities and volume effects, (9) low-pressure discharge parameters, (10) discharges in different field configurations, (11) hf discharges, (12) crossed field, and (13) magnetron and PIG discharges. (M.O.W.)

7308 HIGH-PRESSURE DISCHARGES. pp 191-266 of Eighth International Conference on Phenomena in Ionized Gases, Vienna, Austria, August 27–September 2, 1967. Vienna, Springer-Verlag, 1967.
See CONF-670810.

Seventy-six papers are included on the following subjects: (1) sparks (pre-breakdown and breakdown), (2) sparks (breakdown and growing phenomena), (3) corona, (4) arcs, (5) stabilized arcs, (6) torches and welding arcs, (7) high-current arcs and pulsed arcs, (8) arcs and discharges in magnetic fields, and (9) laser and laser-induced discharges. (M.O.W.)

7309 FUNDAMENTAL PLASMA PROPERTIES. pp 267-99 of Eighth International Conference on Phenomena in Ionized Gases, Vienna, Austria, August 27–September 2, 1967. Vienna, Springer-Verlag, 1967.
See CONF-670810.

Thirty-three papers are included on the following subjects: (1) distribution functions, (2) microdeviation and the Vlasov equation, (3) equilibrium and nonequilibrium effects, (4) basic hydrodynamic phenomena, and (5) miscellaneous. (M.O.W.)

7310 TRANSPORT PROCESSES. pp 300-27 of Eighth International Conference on Phenomena in Ionized Gases, Vienna, Austria, August 27–September 2, 1967. Vienna, Springer-Verlag, 1967.
See CONF-670810.

Twenty-eight papers are included on the following subjects: (1) general transport equations, (2) transport coefficients, (3) electric and thermal conductivity, (4) normal diffusion, and (5) ambipolar and anomalous diffusion. (M.O.W.)

7311 WAVE–PLASMA INTERACTIONS. pp 328-422 of Eighth International Conference on Phenomena in Ionized Gases, Vienna, Austria, August 27–September 2, 1967. Vienna, Springer-Verlag, 1967.
See CONF-670810.

Ninty-five papers are presented on the following subjects: (1) general theory and electrostatic waves, (2) electromagnetic waves in cylindrical columns, (3) miscellaneous electronic waves, (4) pseudo-acoustic waves, (5) miscellaneous ionic waves, (6) general theory of beam plasma waves and synthesized plasma, (7) high-frequency fields and nonlinear effects in beam–plasma systems, (8) cyclotron oscillation in beam–plasma systems, (9) acceleration and heating of plasmas by progressive waves, (10) transformation of waves, (11) instabilities, turbulence, and miscellaneous nonlinear effects, (12) Q-machines, and (13) ionization waves. (M.O.W.)

7312 PLASMA RADIATION. pp 423-58 of Eighth International Conference on Phenomena in Ionized Gases, Vienna, Austria, August 27–September 2, 1967. Vienna, Springer-Verlag, 1967.
See CONF-670810.

Thirty-six papers are included on the following subjects: (1) microwave emission, (2) broadening and shift of spectral lines, (3) miscellaneous studies of spectra and radiation, and (4) spectrographic investigation of different plasma. (M.O.W.)

7313 SHOCK WAVES. pp 459-76 of Eighth International Conference on Phenomena in Ionized Gases, Vienna, Austria, August 27–September 2, 1967. Vienna, Springer-Verlag, 1967.
See CONF-670810.

Eighteen papers are included on shock studies in plasma. (M.O.W.)

7314 MEASUREMENT OF THE VELOCITY PROFILE OF THE HOMOPOLAR PLASMA COMPONENT. Odintsova, G. A. Zh. Prikl. Spektrosk., Akad. Nauk BSSR, 7: 414-16(Sept. 1967). (In Russian).

The velocity of ions and neutrals in homopolar devices was measured using the Doppler broadening of spectral lines. (tr-auth)

7315 CALCULATION OF POTENTIAL IN PENNING CELL IN THE PRESENCE OF A SPATIAL CHARGE. Ivanova, T. I. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 1193-6(1967). (In Russian).

A negative space charge exists between the electrodes during discharge in a Penning cell in the case of low pressure and a strong magnetic field. A solution of the Poisson equation is obtained in the case, where the space charge is homogeneously distributed within the cylindrical layer. Since in most cases the distribution of charge can be represented in the form of a number of cylindrical layers which differ from each other in radius, length and charge density within the layer, the solution can be extended to the case of an uneven distribution of charge. The distribution of potential along the axis of discharge and along the radius in the plane of symmetry of the discharge interval is given for various values of the charge density, and for various cell geometries and electrode potentials. (TTT)

7316 EFFECTIVE DRAG WIDTH OF SHORT MOVING ARCS IN ARGON. Naylor, K. A.; Guile, A. E. (Univ. of Leeds, Eng.). Brit. J. Appl. Phys., 18: 1295-1300(Sept. 1967).

Previous experiments have shown that short arcs rotating between ring-shaped electrodes in a radial magnetic field move at a speed which is controlled by aerodynamic drag on the arc column when the pressure is above 1 to 2 atm. For these conditions it is possible to calculate an effective average arc size (which includes a drag coefficient) transverse to the direction of motion. Measurements were made which enable the change in this effective arc size due to (a) arc speed, (b) arc current, (c) inter-electrode spacing and (d) gas pressure to be estimated for arcs moving in argon at a pressure of 3 atm. These changes are shown for arc speeds up to 80 m sec^{-1}, arc currents up to 700 A and for spacings up to 1 cm, and it is suggested that electrode material introduced by vapour jets may be a significant factor. (auth) (UK)

7317 PRESSURE-DEPENDENT TRANSITION IN THE BEHAVIOUR OF Z-PINCHED DISCHARGES. Burgess, D. D.; Dangor, A. E.; Jenkins, J. E. (Imperial Coll. of Science and Tech., London). Brit. J. Appl. Phys., 18: 1281-5(Sept. 1967).

Observations on two dissimilar z-pinched discharges have revealed a sharp transition in their behaviour as the initial filling pressure is varied. Measurements were made interferometrically, spectroscopically, and with a framing camera. The results are most striking for the variation of the peak electron density reached in the plasma, but other parameters also show changes at a critical value of the filling pressure. The interpretation of the observations is briefly discussed. (auth) (UK)

7318 INFLUENCE OF THE RELAXATION OF THE ELECTRON ENERGY DISTRIBUTION ON THE STATISTICS OF ELECTRON AVALANCHES. Legler, W. (Univ., Hamburg). Brit. J. Appl. Phys., 18: 1275-80(Sept. 1967).

The distribution of sizes of electron avalanches produced in a gas by an electric field at high values of E/p is influenced by the relaxation processes in the electron energy distribution after an ionization. The description of this influence requires an ionization coefficient which depends on the avalanche size n as well as on the distance from the cathode. Lack of information on this dependence prevents a rigorous calculation of the avalanche distribution. Recently Cookson and Lewis [ibid 17: 1473-81 (1966)] suggested a solution of the problem by the introduction of an ionization coefficient depending on n only. It is shown that this proposal must be rejected for physical reasons. An approximate solution previously given by the author, which is based on the concept of an "individual" ionization coefficient, is compared with the Polya distribution discussed by Cookson and Lewis and other authors. (auth) (UK)

7319 SOME ESTIMATES OF THE RADIATIVE ROSSELAND MEAN OPACITY. Huebner, Walter F. (Los Alamos Scientific Lab., N. Mex.). J. Quant. Spectrosc. Radiation Transfer, 7: 943-9(Nov.-Dec. 1967).

The effect of atomic number Z on the Rosseland mean opacity is presented in graphic form for a large range of temperatures and densities. This permits a rapid determination of the dominant process and, in many cases, greatly simplifies the calculation of a good approximation of the Rosseland mean opacity. (auth) (UK)

7320 STUDY OF THE CONTINUUM SPECTRUM IN THE VISIBLE REGION OF AN ARGON PLASMA TORCH JET. Chapelle, J.; Decroisette, M.; Cabannes, F. (CNRS, Bellevue, France). J. Quant. Spectrosc. Radiative Transfer, 7: 571-80 (July-Aug. 1967). (In French).

The absolute emission continuum in the visible region in the jet of an argon plasma torch was measured and the experimental results compared with theories of Kramers, of Biberman, Norman, and Ulyanov and of Schlüter. The last theory explains satisfactorily the decreasing intensity of the continuum in the ultraviolet and yields temperature values in agreement with results obtained from other processes (absolute continuum, broadening of the Hβ line when argon contains hydrogen as an impurity, absolute intensity of the AI 4044 Å line, temperature of neutral species). (auth) (UK)

7321 STATIONARY ION WAVES IN IONIZED RARE GAS. Doucet, H. (Ecole Polytechnique, Paris). J. Phys. (Paris), 28: 765-75(Oct. 1967). (In French).

Steady-state ion waves were studied in noble gas discharges at low pressure. Current amplification was found to be large enough to balance collisional damping of the wave. Wave production and reflection on a hot cathode were investigated. (auth)

7322 THEORY OF CYCLOTRON WAVES IN A COLD PROPAGATING PLASMA. Fedorchenko, A. M. Radiotekh. Elektron., 12: 1435-9(Aug. 1967). (In Russian).

On the basis of the investigation of the exact dispersion equation of cold plasma, traveling in a magnetic field, it was shown that such a system does not have amplifying properties, in spite of which in some frequency intervals the dispersion equation has a complex solution. The existence of stationary solutions was shown. (tr-auth)

7323 COUPLED WAVE EQUATIONS FOR PROPAGATION IN INHOMOGENEOUS COMPRESSIBLE PLASMAS. Burman, R. (Victoria Univ. of Wellington, New Zealand). Proc. Cambridge Phil. Soc., 63: 1229-46(Oct. 1967).

Wave propagation in inhomogeneous compressible electron plasmas is discussed. The waves are described by Maxwell's equations coupled to the linearized single-fluid equations of hydrodynamics. Coupled wave equations are derived which describe the propagation of coupled electromagnetic and electron acoustic waves. Results are obtained for generally inhomogeneous plasmas, and are specialized to planar and cylindrically stratified media. Particular attention is given to the planar case and several approximate techniques for treating the equations are discussed. The fields in a region of coupling are investigated. (auth) (UK)

7324 CORRELATION FUNCTIONS AND THE PRESSURE OF A NONISOTHERMAL PLASMA. Medvedev, E. S. (Moscow Physical-Technical Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 6, 87-92(1967). (In Russian).

The effect of weakly damped waves on the correlation functions of a nonisothermal plasma is investigated. Expressions are obtained for the correlation functions of a classical, nonisothermal, two-component plasma. In the limiting case where the electron temperature $\theta_e \gg$ the ion temperature θ_i, there are strong correlations due to the presence of weakly damped waves (ion acoustic), whose phase velocity lies between the thermal velocities of the particles $U_e \gg \omega/k \gg U_i$. In this case the addition to the pressure due to the coulombic interaction changes sign in comparison with the case of thermodynamic equilibrium, where these waves are absent. (TTT)

Production of Plasma

7325 (WERL-3472-8) PLASMA PRODUCTION BY A HIGH-POWER Q-SWITCHED LASER. Quarterly Progress Report 3 for Period from August 1, 1967 to October 31, 1967. Engelhardt, A. G. (Westinghouse Research Labs., Pittsburgh, Pa.). Nov. 1, 1967. Contract AT(30-1)-3472. 22p. Dep. CFSTI.

During this period the operation of the pedestal system has been improved by the insertion of apparatus which monitors the retraction velocity, and prevents the laser from being triggered while the pedestal is in the fire position. Microwave, fast-camera, and energy absorption studies were made in the absence of a magnetic field. The targets have been single isolated aluminum spheres ranging from 40 to 150 μ in radius. Theoretical studies are discussed. (M.O.W.)

7326 AFTERGLOW OF A PULSED DISCHARGE IN MERCURY VAPOR. Skrebov, V. N. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 111-14(Aug. 1967).

Translated from Opt. Spektrosk., 23: 205-12(Aug. 1967).

Observations of the afterglow of a pulsed discharge in mercury vapor (P = 0.2–1 mm, I_{max} = 30–100 A/cm²) are reported. The recombination rate for triple collisions is calculated approximately. The results of the calculations are compared with the previously measured rate of population of the $6^3P_{0,1,2}$ levels in the course of plasma decay. The character of the afterglow is governed by the above type of recombination. However, certain peculiarities are observed in the intensity of the afterglow of the lines (transitions $6^3D_{1,2,3}-6^3P_{0,1,2}$); these peculiarities are connected with the important role played by delayed emission. (auth)

7327 TEMPORAL GROWTH OF IONIZATION IN DEUTERIUM. Powell, W. D.; Davies, M. H.; Morgan, C. Grey (University Coll., Swansea, Wales). Brit. J. Appl. Phys., 18: 1599-1605(Nov. 1967).

Measurements of the rate of growth of small ionization currents (10^{-10} to 10^{-5} A) in uniform electric fields E were made for deuterium between plane parallel gold electrodes in the range 54 < E/p_0 < 155 V cm^{-1} $torr^{-1}$ and 1.9 < p_0 < 12.9 torr. The growth times lay between 10^{-6} and 10^{-4} sec for overvoltages up to approximately 4% in excess of the static sparking potential. Davidson's analysis was used to evaluate the growth constant and to assess the absolute magnitudes of the secondary ionization processes. The values of the secondary coefficients are compared with similar data for hydrogen and it is concluded that the active secondary processes are the same in both isotopes. The photoelectric efficiency of the gold cathode deduced from the measurements is approximately 10^{-3} electrons per quantum. (auth) (UK)

Stability of Plasma

7328 (COO-1695-5) PLASMA INSTABILITIES AND WAVES EXCITED BY AN ANISOTROPIC ENERGY DISTRIBUTION PRODUCED BY ELECTRON CYCLOTRON RESONANCE. Annual Progress Report. Shohet, J. L. (Wisconsin Univ., Madison. Dept. of Electrical Engineering). Dec. 15, 1967. Contract AT(11-1)-1695. 35p. Dep. CFSTI.

The research is being conducted to investigate the ability of a short pulse of electron cyclotron resonance radiation to produce an anisotropic energy distribution of electrons in a plasma, and the instabilities and waves produced by this anisotropy. In particular, the nature of the rf heating mechanism and the behavior of the radiation emitted from the plasma will be considered. During this period the electron cyclotron resonance apparatus was assembled and measurements were made of the plasma dismagnetism and x-ray flux emitted from the device. A theoretical treatment which explains the production of free–free bremsstrahlung from an electron cyclotron resonance plasma has been developed. (M.O.W.)

7329 (LA-3749) CALCULATION OF HIGH BETA TOROIDAL PLASMA EQUILIBRIUM. Oliphant, Thomas A. (Los Alamos Scientific Lab., N. Mex.). July 10, 1967. Contract W-7405-eng-36. 10p. Dep. CFSTI.

A numerical procedure is described for calculating a high-beta, thin-skinned, toroidal plasma equilibrium. The mathematical problem involved is the solution of Maxwell's equations with a boundary between a perfectly conducting plasma and the magnetic field. This boundary must take such a shape that the magnetic field-plasma pressure balance relation holds. The mathematical problem is formulated in detail and a numerical example is presented which possesses very reasonable geometric properties, and which has external fields similar to those contemplated for the Scyllac toroidal θ pinch. (auth)

7330 INSTABILITIES IN A TRAVELING PERIODIC BUMPY THETA PINCH. Troyon, F. (Laboratoire de Recherches en Physique des Plasmas, Lausanne, Switzerland). Phys. Rev. Lett., 19: 1463-5(Dec. 25, 1967).

A $\beta = 1$ theta pinch which, according to Haas and Wesson, would be stabilized by a traveling wave is shown to be unstable. The plasma is described by the incompressible fluid model. It is shown that most of the modes, $m \gtrsim 1.75\delta^{-1}$, are unstable where δ is the ratio of the amplitude of the radius modulation to the mean radius of the pinch. (auth)

7331 END STABILIZATION EFFECT IN THE SLOW THETA PINCH. Miyamoto, Tetsu; Hamada, Shigeo; Ohnishi, Haruyuki (Nihon Univ., Tokyo). J. Phys. Soc. Jap., 23: 1131-7(Nov. 1967).

The m = 1 mode of perturbation is artificially introduced by a parallel displacement of the driving field. The plasma is found to be stabilized against the m = 1 mode. The stabilizing effect is due to the plasma near and outside the mirror points, which is frozen on outwardly concave lines of force; the effect is not the so-called line-tying effect. Exclusion of the exterior plasma by glass plates results in this conclusion. An inclined glass plate pushed the plasma column toward the side of the obtuse angle between its surface and the field lines. A funnel-shaped glass cone has a stabilizing effect. (auth)

7332 ATTEMPT TO GENERATE PLASMA OSCILLATIONS WITH A RELATIVISTIC ELECTRON BEAM. Mendell, J. S.; Holt, E. H. (Rensselaer Polytechnic Inst., Troy, N. Y.). J. Appl. Phys., 38: 5416-17(Dec. 1967).

The study of plasma oscillations has been called the first problem of plasma physics and remains of great current interest. An experimental attempt to stimulate oscillations in a plasma by an external electron beam premodulated at the plasma frequency is described. (W.D.M.)

7333 STABILITY OF PLASMAS. Francis, Gordon (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Sci. Progr. (London), 55: 53-72(Spring 1967).

The basic concepts of containment of plasma by magnetic fields, and the various shapes of fields which have been tried experimentally are reviewed. The dominant factor has proved to be the curvature of the field lines, and by suitably controlling this the most violent instability, the interchange instability, can be suppressed. Other instabilities remain, however, which grow more slowly and depend upon details of the velocity and density distribution of the plasma particles. (auth) (UK)

7334 EXPERIMENTAL OBSERVATION AND THEORETICAL INTERPRETATION OF LOW-FREQUENCY INTERCHANGE INSTABILITY IN "AVERAGE MINIMUM-B" CONFIGURATIONS. Ohkawa, Tihiro; Yoshikawa, Masaji (General Dynamics, General Atomic Div., San Diego, Calif.). Contract AT(04-3)-167. Phys. Rev. Lett., 19: 1374-6(Dec. 11, 1967).

The motion of a particle under an electric field having a component only in the z direction and lasting for a period Δt, was considered. The adiabatic limit and the nonadiabatic limit are considered. The dispersion relation was calculated for the nonadiabatic case. The electrostatic approximation was used assuming that plasma pressure is small compared with magnetic pressure. (M.H.R.)

7335 DRIFT-WAVE STABILIZATION BY RANDOM FIELDS. Thomassen, K. I. (Stanford Univ., Calif.). Contract AT(04-3)-326. Phys. Lett., 26A: 22-3(Dec. 4, 1967). (SU-IPR-193).

A drift wave in a sodium plasma in a slight mirror field is stabilized by applying a random electric field across the column whose spectrum spans the range of cyclotron frequencies in the plasma. A physical explanation is suggested. (auth)

7336 STABILIZATION OF DENSITY-GRADIENT INSTABILITIES BY THE DISPERSION OF CURVATURE DRIFT VELOCITY. Laval, G.; Maschke, E. K.; Pellat, R.; Vuillemin, M. (Euratom-CEA sur la Fusion, Fontenay-aux-Roses, France). Phys. Rev. Lett., 19: 1309-11(Dec. 4, 1967).

In plasma stability calculations, the dispersion of the velocities of particle drifts in a curved magnetic field is usually neglected. If the dispersion of curvature drift velocities is taken into account, the low-frequency electrostatic drift instabilities driven by a density gradient are stabilized by ion Landau damping in the direction of the curvature drift. Examples of marginal stability curves demonstrate the importance of this effect. (auth)

Thermonuclear Processes

Refer to abstract 6702.

Shielding

Refer also to abstract 6953.

7337 (JINR-P16-3593) RASCHET ENERGETICHESKOGO RASPREDELENIYA NEITRONOV VYSOKIKH ENERGII V ZASHCHITE. (Calculation of Energy Distribution of High-Energy Neutrons in the Shielding). Sychev, B. S. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1967. 27p. (In Russian). Dep.

An approximate method of calculation is given for the energy distribution of E > 20-MeV neutrons in a semi-infinite shielding, the surface of which is exposed to the neutrons with the initial energy of some hundreds of MeV. (auth)

7338 (ORNL-TM-1965) NEUTRON TRANSPORT STUDIES IN DUCTS AND SIMPLE SHIELDS: COMPARISON OF MONTE CARLO AND DISCRETE ORDINATES CALCULATIONS WITH EXPERIMENTAL RESULTS FROM THE TOWER SHIELDING FACILITY. Clifford, C. E.; Muckenthaler, F. J.; Maerker, R. E.; Straker, E. A.; Mynatt, F. R. (Oak Ridge National Lab., Tenn.). Oct. 6, 1967. Contract W-7405-eng-26. 55p. (CONF-670932-3). Dep. CFSTI.

From International Conference on the Physics Problems of Reactor Shielding, Harwell, England.

A development program for neutron transport calculational techniques has included a series of experiments at the Tower Shielding Facility to measure neutron dose distributions in ducts and neutron energy spectra transmitted through simple shields. The experiments have been used to guide the development of a simplified Monte Carlo method for calculating neutron transmissions through ducts and to guide the development of the discrete ordinates techniques. Measurements of neutron spectra at specific emergent angles from slab shields of polyethylene and lead have been used to verify the discrete ordinates techniques and to aid in the selection of calculational parameters (space, angle and energy meshes, and order of Legendre expansion of the differential scattering cross sections) for use in a two-dimensional code that has recently been developed at Oak Ridge. Cross sections for use in the above neutron transport calculations have been selected on the basis of measurements of the uncollided neutron spectra through thick samples of shield materials. (auth)

7339 (ORNL-tr-1793) ENERGY FLUX OF GAMMA RADIATION FOR LARGE DEPTHS OF PENETRATION. Krueger, F. W. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Kernenergie, 10: 147-9(1967). 4p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

For large distances from a monoenergetic source the energy flux is proportional to the quantity $e^{-\mu_0 z} z^{k_0 - p}$, where μ_0 is the absorption coefficient for the primary radiation and z is the distance from the source. The parameter p is determined by the geometry of the source. The exponent κ_0 is dependent on the initial energy of the material in which the radiation is propagated. Values of κ_0 were calculated for H, Be, C, Na, Mg, Al, Si, Sn, W, Pb, U, and water. The results are shown in a table. (auth)

7340 INVESTIGATIONS OF RADIATION METERS. NEUTRON SHIELDING PROPERTIES OF VARIOUS MATERIALS. Yuhara, Jiro; Urai, Tatsuo (Technical Research and Development Inst., Japan Defense Agency). Giho (Boeicho Gijutsu Kenkyu Honbu), 5: No. 35, 1-12(Jan. 1966). (In Japanese).

In view of the remarkable advance in the development of powerful atomic weapons, the neutron shielding properties were investigated for various materials used in shelters, armours, and other structures. The thickness t_n in which the incident radiation I_0 is reduced to $I_0 \times 10^{-n}$ can be expressed as $t_n = 2.3026\ \lambda n$, where λ is the relaxation length, i.e., the reciprocal of the effective removal cross section, Σ_r. The Σ_r is given by $\Sigma_r = \rho N \sigma_r / A$, where ρ is the density, N the Avogadro number, σ_r the atomic cross section, and A the atomic weight. The values of λ (in cm) obtained are 5.95 for iron, 5.96 for low carbon steel, 5.4 for B-steel, 6.25 for stainless steel (JIS G4301), 12.6 for aluminum, 12.02 for duralumin (JIS H4105), 11.1 for Portland concrete, 6.6 for W-I concrete, and 8.0 for barite concrete. The relationship between the biological effect of neutrons from a standard atomic bomb and the distance of shielding materials from the bomb explosion is also given. (NSA of Japan)

7341 DIFFERENTIAL ALBEDO FOR γ RAYS FROM POINT MONODIRECTIONAL SOURCE. Viktorov, A. A.; Efimenko, B. A.; Zolotukhin, V. G.; Klimanov, V. A.; Mashkovich, V. P. At. Energ. (USSR), 23: 187-91(Sept. 1967). (In Russian).

The differential characteristic of the albedo of the γ radiation of point monodirectional sources was calculated by the Monte Carlo method and experimentally studied in the γ energy range from 0.06 to 10.0 MeV for semi-infinite scattering from water, aluminum, iron, and lead. The distribution of the intensity of the back-scattered γ radiation on the surface of the scattering material was experimentally investigated. The applicability of the economy of investigation method to the differential character of the albedo was studied. The error in the determination of the calculated energy, and dose albedo by means of the economy of investigation method does not exceed 15% in all the cases investigated. (tr-auth)

7342 TRANSMISSION THROUGH ALUMINUM OF BETA-PARTICLES EMITTED BY INFINITELY-THICK SOURCES. Rodriguez-Pasques, R. H.; Mullen, P. A.; George, G. A.; Harding, J. E. (National Bureau of Standards, Washington, D. C.). Int. J. Appl. Radiat. Isotop., 18: 835-47(Dec. 1967).

The problem of determining the energy of beta particles emitted from sources containing low concentrations of radioactive substances is examined. Transmission curves of beta particles emitted by "infinitely thick" disc-shaped sources were obtained with two different detectors and compared with the curves similarly obtained for beta particles coming from very thin "weightless" deposits on similar solid discs. Different matrix materials and beta-particle energies were used. The curves were studied for shape, secondary radiations, and half-thickness. A series of curves was also obtained from four different potassium-salt thick sources, in order to investigate possible influences from variations of effective atomic number. No substantial difference was found between the curves corresponding to the three types of sources, with regard to half-thickness maximum-energy relationship. Guiding rules are proposed for the determination of maximum beta-ray energies by means of absorption studies and half-thickness determination. (auth) (UK)

7343 SCATTERING OF COLLIMATED BEAMS OF THE γ RADIATION OF ^{60}Co, ^{137}Cs, AND ^{198}Au ON THE BOUNDARY OF TWO MEDIA. Andryushin, N. F.; Astakhov, V. V.; Bulatov, B. P.; Fradkin, G. M. At. Energ. (USSR), 23: 110-13(Aug. 1967). (In Russian).

The results of the experimental investigation of the intensity of the scattered γ radiation at the air–earth boundary and air–water boundary from the collimated beam, guided either into air or into it from the dense medium, were reported. An analysis was made of the basic physical regularities. Empirical relations were obtained for carrying out engineering calculations at different angles of the collimated beam in a wide range of the scattering measurements (up to 100 m). The deviation of the calculated values from experimental data does not exceed ±20%. (tr-auth)

Solid-State Physics

Refer also to abstracts 6562, 6675, 7073, 7212, 7406, 7465, 7695, and 7702.

7344 (ANL–7381) STATISTICAL THEORY OF ELECTRIC POLARIZATION. Bellemans, A. (Argonne National Lab., Ill.). Aug. 1967. Contract W-31-109-eng-38. 48p. Dep. CFSTI.

The present situation in the statistical theory of dielectrics is reviewed, as far as linear effects in the field are concerned. The theory of the static dielectric constant and of the dynamic (frequency dependent) dielectric function is covered. (M.H.R.)

7345 (NP-17133) COUPLAGE QUADRUPOLAIRE ET STRUCTURES CRISTALLOGRAPHIQUES ET MAGNETIQUES DE QUELQUES COMPOSES IONIQUES DU FER. (Quadrupole Coupling and Crystallographic and Magnetic Structures of Several Ionic Compounds of Fe). Chappert, J. (Grenoble Univ. (France). Faculte des Sciences). [Sept.] 1966. 30p. (In French). Dep. Thesis.

The Moessbauer effect (^{57}Fe) was used to study the ionic compounds of trivalent Fe: Fe_2O_3CaO, FeOF, and $Fe_xMn_{1-x}TO_3$ (T = rare earth or yttrium). Information concerning the crystallographic structure is obtained by investigating the electric field gradient (EFG) of the pure electric quadrupole interaction is known (no magnetic interaction). In the case of Fe_2O_3CaO, the Fe ions are located in two different crystallographic sites, and the observed interactions are compared with the interactions calculated from the crystallographic data. For FeOF, the broadening of the spectrum lines indicates an anionic disorder in qualitative agreement with the calculations of the EFG. In $Fe_xMn_{1-x}TO_3$, the crystallographic symmetry of which is hexagonal or orthorhombic depending on x and T, a correlation between the quadrupole coupling and the distortion of the structure is observed. When there is an additional magnetic interaction, the line positions of the hyperfine spectrum depend on the angle between the major principal axis of the EFG and the spin direction. Thus for FeOF a possible magnetic structure is predicted and checked by neutron diffraction. In hexagonal $Fe_xMn_{1-x}YO_3$ the experimental values of the line positions agree with the magnetic structure determined by Bertaut et al. (auth)

7346 (NYO–2028-2) NUCLEAR REACTIONS IN LIGHT NUCLEI AND MOESSBAUER STUDIES. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics). Sept. 1967. Contract AT(30-1)-2028. 169p. Dep. CFSTI.

Separate abstracts were prepared for 18 of the 21 sections presented. Three papers were in summary form and were not abstracted for NSA. (B.G.D.)

For abstracts of individual sections see: 6562, 6675, 7212, 7347–7349, 7640, 7641, 7660, 7694–7700, 7743, and 7744.

7347 (NYO–2028-2, pp 47-56) [MOESSBAUER EFFECT IN] ^{57}Fe AT HIGH TEMPERATURES. Kovats, T. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics).

Several modifications have been made in the apparatus for observing the Moessbauer effect in ^{57}Fe at high temperatures; the preliminary data which have been taken indicates oxidation difficulties. The apparatus is described. (M.O.W.)

7348 (NYO–2028-2, pp 63-6) MOESSBAUER EFFECT STUDIES OF YTTERBIUM IRON GARNET. Gleason, T.; Hershkowitz, N. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics).

Data showing the ^{170}Yb Moessbauer spectra in YbIG are given. (M.O.W.)

7349 (NYO–2028-2, pp 74-83) MOESSBAUER STUDIES OF DySb. Loh, E.; Oleson, J. R.; Walker, J. C. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics).

The Moessbauer spectra at different temperatures are discussed. (M.O.W.)

7350 (NYO–3657-2) THEORETICAL RESEARCH ON RADIATION INDUCED DEFECTS IN LiH. Progress Report. Hatcher, Robert D. (Queens Coll., New York. Dept. of Physics). Dec. 1967. Contract AT(30-1)-3657. 38p. Dep. CFSTI.

A point ion model with repulsive two-body interactions calculated in the Heitler–London approximation was used to obtain the cohesive energy, lattice parameter, compressibility, and elastic constants for the LiH crystal. A quantum mechanical calculation involving three or seven ions instead of two, now in a preliminary stage, is considered briefly. Results of calculation of relative frequency distribution and resonant frequency for LiH from the point ion model are tabulated. A new method for computing the polarization energy in defect problems is outlined. The method is tested on two cases where the experimental results are well known: calculation of the energy of a Schottky pair in KCl and calculation of the activation energy for an interstitial Cl^- in KCl. The response of a lattice to a small additional charge is examined in terms of the relaxation of the ions. Calculations for LiH using the new methods and interactions are presented. The energy of a Schottky pair and the relaxation around positive and negative ion vacancies in LiH are given. The relaxation around an interstitial He atom is discussed and the activation energy for motion is calculated. (A.G.W.)

7351 (NYO–3823-1) EXPERIMENTAL STUDIES OF CRITICAL POINT BEHAVIOR IN MAGNETICALLY ORDERED SOLIDS USING NUCLEAR GAMMA-RAY-SPECTROSCOPY. Annual Progress Report No. 1, February 1, 1967–October 31, 1967. Hohenemser, Christoph (Brandeis Univ., Waltham, Mass. Dept. of Physics). Oct. 31, 1967. Contract AT(30-1)-3823. 5p. Dep. CFSTI.

A slow–fast delayed coincidence system was set up. An effort was made to improve the time resolution for both plastic and NaI scintillators. A vacuum annealing oven was designed and constructed. A preliminary perturbed angular correlation experiment using the 122–14 keV cascade in ^{57}Fe is proceeding. (M.H.R.)

7352 (RT/EL–(67)8) STUDIO DELLA EMISSIONE DI ELETTRONI DA SUPERFICI BOMBARDATE DA IONI DI GAS NOBILI. (Emission of Electrons From a Surface Bombarded by Noble Gas Ions). Catoni, F.; Cipolloni, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1967. 24p. (In Italian). Dep.

An experimental device was constructed for the study of the secondary ion–electron emission in the incident-ion energy range from 200 eV to 4 keV. The experimental conditions are described. The results obtained for Ta and Mo bombarded with ions of Ar^+, He^+, and Kr^+ are shown graphically. The results agree well with data reported previously. (J.S.R.)

7353 (SU-DMS–67-T-9) ELECTRON RADIATION DAMAGE EFFECTS IN II–VI CRYSTALS. PHOTOELECTRONIC EVALUATION OF ELECTRON RADIATION DAMAGE IN CdS CRYSTALS. Progress Report No. 4, June 14–September 13, 1967. Ho Bin Im; Bube, Richard H. (Stanford Univ., Calif. Dept. of Materials Science). Contracts 59-0234; AT(29-1)-789. 25p. (SC-CR-67-2769X). Dep. CFSTI.

The effects of electron radiation damage for electrons with energy between 75 keV and 2 MeV were investigated in CdS single crystals by measurements of dark conductivity, photoconductivity vs. temperature, spectral response of photoconductivity, optical quenching of photoconductivity, and thermally stimulated conductivity. The major effect of electron radiation damage is to decrease the electron lifetime in high-resistivity photosensitive crystals if the electron energy is 400 keV or higher. Relatively minor effects are also observed in dark conductivity, optical quenching, and thermally stimulated conductivity. Low-temperature annealing of irradiated crystals under illumination removes the effects of damage on the electron lifetime. After such annealing, however, all irradiated crystals exhibit a distinctly different trap distribution from nonirradiated crystals, prominent in which is the 289°K trap previously investigated and described as a repulsive trap in CdS and CdSSe crystals. (auth)

7354 (UCRL–17854) MAGNETIC RESONANCE IN ORIENTED NUCLEI. Shirley, D. A. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1967. Contract W-7405-eng-48. 30p. (CONF-670812-17). Dep. CFSTI.

From International Conference on Hyperfine Interactions, Pacific Grove, Calif.

Several new types of experiment that entail radiative detection of NMR are discussed. A brief survey of radiative detection of magnetic resonance in nuclei oriented by equilibrium methods at very low temperatures is given. A critical discussion is given of the hyperfine enhancement factor. Line shapes and resonance destruction are treated. Spin temperatures and spin–lattice relaxation are discussed. (M.O.W.)

7355 (LA-tr-67-115) EXISTENCE OF A MAGNETIC TRANSITION IN URANIUM SESQUICARBIDE U_2C_3. De Novion, C.; Costa, P.; Dean, G. Translated from Phys. Lett., 19: 455-6 (1965). 4p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The magnetic susceptibility of U_2C_3 was measured as a function of temperature up to about 300°K. A Neél point was found at 59°K. The results indicate that U_2C_3 shows a magnetic transition at about 60°K, but, if the transition exists, the variation of entropy connected with it is weak. (A.G.W.)

7356 ON THE INFLUENCE OF CALCINATION AND X-RAY DOSAGE ON THE (EXO)EMISSION OF ELECTRONS AND THERMOLUMINESCENCE OF CaF_2. Sujak, B.; Gieroszynska, K. (Wroclaw Univ.). Acta Phys. Pol., 32: 541-9(1967).

Thermostimulated (exo)emission of electrons (TEE) and thermoluminescence (TL) of CaF_2 were studied for chemically pure samples after their calcination in air and irradiation by x rays. It was found that in case of CaF_2 there are two distinct emission maxima at the temperatures 440 and 515°K, as well as one maximum at 355°K, however, less distinct. Luminescence maxima on the glow curve appear at 355 and 435°K. It is shown that the total number of emitted electrons and the total number of emitted quanta are significantly influenced by (a) the sample calcination temperature, and (b) the dosage of x rays exciting the emission. (auth)

7357 MAGNETOCRYSTALLINE ANISOTROPY OF Gd-Tb AND Gd-Dy ALLOYS. Tajima; Keisuke; Chikazumi, Soshin (Tokyo Univ.). J. Phys. Soc. Jap., 23: 1175(Nov. 1967).

Magnetocrystalline anisotropy constants of 1.8 wt % Tb-Gd and 1.3 wt % Dy-Gd alloys were measured at temperatures from 4.2 to about 200°K at a field strength of 31 kOe. The contribution of Tb or Dy single atoms to the anisotropy of the alloys was determined. The values obtained were about half the values obtained by Rhyne and Clark [J. Appl. Phys., 38: 1379 (1967)]. Possible reasons for the disagreement are considered. (A.G.W.)

7358 ION-PAIR SPECTRA IN RARE EARTH SALTS. Shinagawa, Kohsei (Tokyo Inst. of Tech.). J. Phys. Soc. Jap., 23: 1057-62(Nov. 1967).

An attempt is made to explain the intensities of absorption lines corresponding to the ion-pair transitions first observed by Varsanyi and Dieke for the case of Pr^{3+} ion pairs in $PrCl_3$ crystals. An expression for the transition electric dipole moment is derived following Dexter's model under the two assumptions that the levels of the excited configurations of the type (4f) (n'l') with odd parity are completely degenerate and the charge distributions of the rare earth ions do not overlap. The relative intensities can be explained fairly well except for a few transitions by introducing an empirical parameter adjusted to give a good fit to the observed ones determined by Dieke and Dorman. The values of the parameter are found to be scattered although they should not theoretically. The reason for this discrepancy is discussed. (auth)

7359 ELECTRON SPIN RESONANCE OF GAMMA-IRRADIATED ROCHELLE SALT SINGLE CRYSTAL. I. ANALYSIS OF CENTER NO. 2. Suzuki, Ikuo; Abe, Ryuji (Nagoya Univ., Japan). J. Phys. Soc. Jap., 23: 1049-56(Nov. 1967).

The structure of a radical in gamma-irradiated Rochelle salt, which is named center No. 2, was studied from the electron spin resonance spectra at both X- and K-band frequencies. The principal values of the hyperfine-coupling tensor and g tensor were determined to be 28.0, 17.5, and 8.7 gauss and 2.0067, 2.0043, and 2.0024, respectively. The principal values of the hyperfine-coupling tensor revealed that the radical was a typical ĊH radical. The most probable structure of the radical was determined to be (H)OĊHCOO-. (auth)

7360 RADIOPHOTOLUMINESCENT CENTERS IN SILVER-ACTIVATED PHOSPHATE GLASS. Yokota, Ryosuke; Imagawa, Hiroshi (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan). J. Phys. Soc. Jap., 23: 1038-48(Nov. 1967).

ESR studies of radiophotoluminescence (RPL) centers in silver-activated phosphate glass were performed after the glasses had been γ irradiated at 77°K. It is shown that the silver ions act as traps for both electrons and positive holes. By the separate formation of electron-trapped silver centers and hole-trapped silver centers, it was verified that all these silver centers act as RPL centers. It was found that a positive hole in a PO_4 tetrahedron is transferred to an Ag^+ ion, and this is the main process of RPL buildup. It was found that alkali and or silver ion migration is necessary for stabilization of RPL centers. The reason for high stability and buildup of RPL centers after γ irradiation was clarified. Resonances thought to be due to exchange-coupled pairs, triads, and higher aggregates of electron-trapped silver centers were found. (auth)

7361 RECOMBINATION LUMINESCENCE OF NaI(Tl) PHOSPHOR. Shamovskii, L. M. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 137-9(Aug. 1967).

Translated from Opt. Spektrosk., 23: 254-8(Aug. 1967).

At low temperatures the spectrometric scintillator NaI(Tl) becomes a dosimeter for ionizing radiation. The steady-state brightness of the x-ray luminescence under the thermoluminescence peaks at 135 and 165°K is appreciably increased because of the long component. A small admixture of chlorine ions creates additional trapping levels for electrons and holes in the crystal and the storage ability of NaI(Tl) is increased. The sign of the recombination luminescence changes four times in the interval from 100 to 300°K. (auth)

7362 MAGNETIC PROPERTIES OF NEUTRON-IRRADIATED IRON-NICKEL THIN FILM ALLOY. Tamagawa, Nobuaki (SONY Corp., Yokohama, Japan); Sugiura, Yoshikazu; Harasawa, Susumu. J. Phys. Soc. Jap., 23: 908-9(Oct. 1967).

The investigation was made with pile neutrons on Fe-Ni (50%-50%) thin film. Torque curves before and after irradiation are given. (M.O.W.)

7363 NMR STUDIES OF FERROMAGNETIC Co-Pd ALLOYS. Kubo, Hidenori; Itoh, Junkichi (Osaka Univ.). J. Phys. Soc. Jap., 23: 897(Oct. 1967).

The results of Co and Pd resonances in Co-Pd alloys in fcc phase are reported. The ^{59}Co resonances in alloys containing 1, 2, 5, and 10 atomic percent of Pd were measured by a spin echo method at 77°K. (M.O.W.)

7364 "MIRROR" ABSORPTION AND FLUORESCENCE IN MgO. Nakagawa, Masuo (Kyoto Univ.); Uemura, Yukikazu; Fukuda, Kuniya. J. Phys. Soc. Jap., 23: 1182(Nov. 1967).

Single crystals of MgO were exposed to prolonged neutron irradiation ($\sim 5 \times 10^{18}$ nvt at ~50°C) in the hydraulic tube of the Research Reactor of Kyoto University. Measurements of optical emission and absorption spectra were then made at 77°K. The results confirm the Levshin law of mirror symmetry, i.e., the absorption and fluorescence were found to be mirror images of each other about a zero-phonon line common to both bands. At lower temperatures the zero-phonon absorption peak shifted to higher energy and was enhanced in intensity. (A.G.W.)

7365 ELASTIC CONSTANTS OF TANTALUM MONOCARBIDE, $TaC_{0.90}$. Bartlett, R. W.; Smith, C. W. (Stanford Research Inst., Menlo Park, Calif.). J. Appl. Phys., 38: 5428-9 (Dec. 1967).

Because of its cubic symmetry, tantalum monocarbide crystals have only three elastic constants, C_{11}, C_{12}, and C_{44}, corresponding to dilation normal to the stress, perpendicular to the stress, and in shear. These elastic constants were determined at room temperature for $TaC_{0.90}$ by measuring the velocities of ultrasonic pulses propagated through the samples. (W.D.M.)

7366 SPACE-CHARGE EFFECTS IN INSULATORS RESULTING FROM ELECTRON IRRADIATION. Monteith, L. K. (Research Triangle Inst., Durham, N. C.); Hauser, J. R. J. Appl. Phys., 38: 5355-65(Dec. 1967).

A detailed model of space-charge effects resulting from trapping of thermalized irradiation electrons in insulating materials is presented. Analytical solutions for a particular insulating material (polyethylene terephthalate) were obtained. When the trapping sites are uniformly distributed in energy below the energy level where charge transport occurs, the rate of charge buildup and release depends primarily on a ratio of the material relaxation time constant $\rho\epsilon$ to a release rate of electrons from traps. Agreement between theory and experiment is reasonably good in the case of polyethylene terephthalate when this ratio of time constants is approximately unity. (auth)

7367 LOW-ANGLE SUBGRAIN BOUNDARIES IN TELLURIUM. Hoerl, E. M.; Weiss, J. (Osterreichische Studiengesellschaft fuer Atomenergie, Seibersdorf, Austria). J. Appl. Phys., 38: 5132-8(Dec. 1967). (SGAE-M-10/1967).

A study of low-angle subgrain boundaries in tellurium crystals was carried out using electron microscopical techniques. The existence of symmetric tilt boundaries could be proved by the examination of the electron diffraction patterns and the determination of the Burgers vectors forming the boundaries. The motion of the individual dislocations of a boundary at elevated temperatures was investigated and the effect of irradiation with fission fragments studied. (auth)

7368 LEED STUDY OF THE GROWTH OF ALUMINUM FILMS ON THE Ta(110) SURFACE. Jackson, A. G. (Systems Research Labs., Inc., Dayton, Ohio); Hooker, M. P.; Taas, T. W. J. Appl. Phys., 38: 4998-5004(Dec. 1967).

Growth of aluminum films on clean Ta(110) surfaces was investigated by LEED techniques. Five phases of aluminum were found, which are: (1) disordered Al(111), formed by depositing at T < 600°C; (2) Al(111)c (2 × 2) formed by heating film, deposited

at T < 300°C to 700°C; (3) Al(100)c (2 × 2), formed by heating film, deposited 300 < T < 600°C to 700°C; (4) epitaxial Al(111), formed by depositing film with substrate T in range 600 < T < 670°C; and (5) diffuse phase, formed by heating any of the preceding to 800°C. Two orientations of each structure were observed; this resulted from the close match between primitive unit meshes of aluminum (111), (100), and Ta(110). A mechanism for the growth of Al(111) and Al(100) is suggested. Comparisons with some published LEED data on epitaxy are made. (auth)

7369 SUBSTRATE–CONDENSATE CHEMICAL INTERACTION AND THE VAPOR DEPOSITION OF EPITAXIAL NIOBIUM FILMS. Hutchinson, T. E.; Olsen, K. H. (3M Co., St. Paul). J. Appl. Phys., 38: 4933-7(Dec. 1967).

Investigation of films formed by vacuum depositions of Nb on single-crystal MgO has demonstrated the importance of chemical interaction between the substrate and overgrowth in the epitaxial growth process. The interaction layer is composed of an oxygen-stabilized face-centered cubic modification of the normally bcc Nb, or the compound NbO, the thickness of which is controlled by the oxygen diffusion process in the layer. The previously observed nucleation–coalescence process of thin film formation is replaced by ordered chemical reaction. Defect-producing misorientations between nuclei, predominant in the nucleation–coalescence case, are not present in the ordered chemical reaction process. Thin films may thus be produced having defect density no higher than that of the substrate crystal. The effect of interaction between the substrate and condensate, although large in the example presented, should not be overlooked in other considerations of the epitaxial process where chemical reaction cannot be ruled out. (auth)

7370 AUTORADIOGRAPHY APPLIED TO TRACER STUDIES IN SEMICONDUCTOR RESEARCH. Osborne, James F. (Texas Instruments Inc., Dallas). Int. J. Appl. Radiat. Isotop., 18: 829-33(Dec. 1967).

The single crystal materials and processes used in semiconductor research present unique problems as compared to metals and their alloys. Autoradiography has sometimes been the only technique by which these problems could be investigated. The types of films, their speed and resolution, and the nonconventional use of dental x-ray film employed in these studies are described. The techniques and some specific applications of autoradiography to semiconductor research problems are described. (auth) (UK)

7371 DENSITY MATRICES FOR ATOMS AND SOLIDS. I. EFFECTIVE POTENTIAL MATRIX AND THE BLOCH EQUATION. Hilton, D. (Sheffield Univ., Eng.); March, N. H.; Curtis, A. R. Proc. Roy. Soc. (London), Ser. A, 300: 391-404(Sept. 19, 1967).

By recognizing that the canonical density matrix C can be expressed in terms of an effective potential matrix, U, intimately related to the potential V in which the particles move, a powerful approximate analytic solution of the Bloch equation has been obtained. This solution for U reduces to first-order perturbation theory on C when V is weak, and to the correct Thomas–Fermi result when V is almost constant in space. For an attractive defect centre in a metal, represented by a screened Coulomb potential which is not strong enough to bind an electron, it is shown that this approximate analytic solution may be used successfully in a numerical iterative solution of the Bloch equation, and final numerical results are presented. For more strongly attractive centers, however, where bound states appear, the same numerical iterative scheme proves inadequate. A method is developed which orthogonalizes the approximate analytical density matrix to the wave function product for the lowest bound state. The new density matrix thereby formed is tested, and found to work successfully for an unscreened Coulomb field. This approach is then worked out for a screened potential created by a charge Z = 4 in a Fermi gas of density equal to that in Cu metal. Such a charged center brings down a bound state from the conduction band, and it is shown that the method employed successfully for the bare Coulomb field also leads to an accurate solution of the Bloch equation in this case. It is concluded that this constitutes a sufficiently powerful iterative scheme to carry out Hartree self-consistent calculations based on the Dirac density matrix, both for atoms, where the Fermi level lies in the bound state region, and for defects in metals, where the Fermi energy falls in the continuum. Such calculations are in progress. (auth) (UK)

7372 VACANCY ANNEALING IN THREE DIFFERENT EXPERIMENTS IN GOLD. Sharma, R. K.; Lee, C.; Koehler, J. S. (Univ. of Illinois, Urbana). Contracts AT(11-1)-1198; DA-31-124-ARO(D)-65. Phys. Rev. Lett., 19: 1379-81(Dec. 11, 1967). (COO-1198-472).

The results of experiments are reported in which vacancies were introduced into very pure gold by quenching, by 3-MeV electron irradiation at 100°K, and by a few percent tensile deformation at 4.2°K. In all cases a prominent annealing process is observed which occurs in the range from 20 to 80°C (for the concentration used) with an activation energy in the purest specimens of 0.90 ± 0.06 eV. (M.H.R.)

7373 COHESION OF IONIC CRYSTALS OF ALKALI METAL AND NOBLE GAS ATOMS. Heller, W. R. (IBM Research Lab., San Jose, Calif.). Phys. Lett., 26A: 54-5(Dec. 4, 1967).

Use is made of the simplest version of the Born theory of ionic crystals, together with relatively recent work on electron affinities and lattice parameters, to show that noble gas salts of the alkali metals should exist. (auth)

7374 ATOMIC ENVIRONMENT EFFECT ON THE MAGNETIC PROPERTIES OF VAu_4. Claus, H.; Sinha, A. K.; Beck, P. A. (Univ. of Illinois, Urbana). Contract AT(11-1)-1198. Phys. Lett., 26A: 38-41(Dec. 4, 1967).

Susceptibility data for disordered VAu_4 and for ordered $(V_{0.9}Ta_{0.1})Au_4$ and $(V_{0.8}Nb_{0.2})Au_4$ suggest that a moment occurs only at V atoms having no V nearest neighbors, but that the moment increases with increasing number of V second- and third-nearest neighbors. (auth)

7375 MOESSBAUER EFFECT IN CALCINATED $FePO_4$ BELOW 26°K. Bruckner, W.; Fuchs, W.; Ritter, G. (Univ., Erlangen-Nuernberg, Ger.). Phys. Lett., 26A: 32-3(Dec. 4, 1967).

Moessbauer effect studies in external magnetic fields indicate that calcinated $FePO_4$ is antiferromagnetically ordered below 25°K. (auth)

7376 ON THE 16°K ANOMALY IN EUROPIUM METAL. Lounasmaa, O. V.; Kalvius, G. M. (Argonne National Lab., Ill.). Phys. Lett., 26A: 21-2(Dec. 4, 1967).

Moessbauer measurements in the temperature range between 4.2 and 196°K on a sample of europium metal reveal that the transition at 16.1°K, previously observed in specific heat data, is due to an impurity—most likely EuH_2. (auth)

7377 QUANTITATIVE ESTIMATES OF SITE POPULATIONS IN AN AMPHIBOLE BY THE MOESSBAUER EFFECT. Bancroft, G. M. (Cambridge Univ., Eng.). Phys. Lett., 26A: 17-18(Dec. 4, 1967).

A method is formulated so that quantitative estimates of the amount of iron in structurally different positions (site populations) can be rapidly obtained in silicate minerals. The results for a cummingtonite agree closely with x-ray crystallographic results for a cummingtonite of similar composition and origin. (auth)

7378 STUDY OF PROTON DYNAMICS IN PARAELECTRIC KH_2PO_4 BY QUASI-ELASTIC COLD NEUTRON SCATTERING. Blinc, R.; Dimic, V.; Petkovsek, J.; Pirkmajer, E. (Univ., Ljubljana, Yugoslavia). Phys. Lett., 26A: 8-9(Dec. 4, 1967).

The width of the quasi-elastic peak of cold neutrons scattered on paraelectric KH_2PO_4 was measured as a function of temperature and momentum transfer, and the mean time between two successive proton jumps from one off-center equilibrium site in the O–H–O bond to another was determined. (auth)

7379 SINGULARITIES OF THE KINETICS OF HEALING OF TRACKS PRODUCED BY URANIUM FISSION FRAGMENTS IN THIN MICA PLATES. Geguzin, Ya. E.; Berzina, I. G.; Vorob'eva, I. V. (All-Union Scientific Research Inst. of Nuclear Geophysics and Geochemistry, USSR). Dokl. Akad. Nauk SSSR, 175: 807-9(Aug. 1, 1967). (In Russian).

Studies were continued on the behavior of tracks produced in mica by uranium fission fragments, which showed that the track is not under dynamic equilibrium because of the presence of a chemical gradient and an interphase surface energy on its boundary. The nature of the motion of the boundary between the defective region (track) and the region without defects was investigated using two sets of experiments, one consisting of subjecting the mica plates with the tracks to isothermal annealing of different duration and investigating the track behavior by etching and examination in an optic microscope. The second series of experiments was aimed at tracing differences in the thermal stability of tracks in crystals and thin plates. The first series of experiments showed that in thin samples, in which the track emerges to the surface, the boundary of the track does not move parallel to itself, but bends inward in the track. The surfaces come closer together in the middle of the track than at the ends, thus breaking the track into two. The second set of experiments showed that the tracks in a thin plate are thermally more stable than in a bulky sample of mica. The aggregate of the experimental data was explained by assuming that the free surfaces between the defective region and the vacuum, on which the track terminates, hinder the motion of the interface between the defective and nondefective regions. Theoretical calculations supporting this conclusion are presented. (ATD)

7380 ON THE NATURE OF HOLE CENTERS IN IRRADIATED ALKALINE–SILICATE GLASSES. Sidorov, T. A.; Tyul'kin, V. A. Dokl. Akad. Nauk SSSR, 175: 872-4(Aug. 1, 1967). (In Russian).

To obtain data on the structure of paramagnetic centers, studies were made of the hyperfine interactions of nonevaporated electrons or holes localized near nuclear magnetic moments. Samples of SiO_2, enriched with 68 and 4.7% ^{28}Si, respectively, were used for preparing glass of the following composition: $Na_2 6SiO_2$, $2Na_2O \cdot 6SiO_2$, $2K_2O \cdot 6SiO_2$ and $3K_2O \cdot 6SiO_2$. All glass specimens were irradiated with ^{60}Co γ rays with doses of 10^7 r. The EPR spectra of the sodium and potassium glass are given in graphical form. Using the model of the paramagnetic center it was possible to evaluate the contribution of the hyperfine spallation value which was found to be equal to 20 Oe. The data obtained confirmed the assumption that the line with g = 2.01 originates in the hole center localized at the oxygen atom. The position and the width of the α component do not depend on the type of alkali cation, therefore the line is the result of the hole localization at the terminal non-joined oxygen atom. (R.V.J.)

7381 STRUCTURE OF AMORPHOUS GERMANIUM OBTAINED FROM CRYSTALLINE GERMANIUM BY BOMBARDMENT WITH ARGON IONS. Pavlov, P. V.; Tetel'baum, D. I. (Gorky Research Inst. of Physics and Technology, USSR. Gorky State Univ., USSR). Dokl. Akad. Nauk SSSR, 175: 823-5(Aug. 1, 1967). (In Russian).

Experiments were carried out with germanium coating blown in vacuum on 500-Å NaCl layers and heated to 400°C. Electronographic pictures taken before the 50-keV argon ion bombardment showed that the coatings are polycrystalline. Photometric diagrams indicate the maximum positions of the curves and interatomic distances in crystalline germanium and radial distribution curves for the amorphous germanium. (R.V.J.)

7382 FIELD INHOMOGENEITY CORRELATION EFFECTS IN NUCLEAR MAGNETIC DOUBLE-RESONANCE DETECTION OF VERY SMALL SPIN-COUPLING CONSTANTS. Freeman, R.; Gestblom, Bo (Varian Associates, Palo Alto, Calif.). J. Chem. Phys., 47: 2744-53(Oct. 15, 1967).

Double-irradiation techniques may be used to detect nuclear magnetic resonance splittings that are so weak as to be obscured by the broadening due to spatial inhomogeneity of the applied magnetic field. The basis for these experiments is the fact that the observable double-resonance effects result from interactions on the molecular scale (such as spin–spin coupling) with the result that the two nuclear sites, A and X, experience almost exactly correlated local fields due to nonuniformity of the applied magnetic field. One such correlation effect is the partial compensation of field inhomogeneity broadening of lines that are regressively connected to the irradiated line. A second correlation effect may be observed if the intensity of a given line with a radio frequency field is so weak that its influence is restricted to sample regions very close to the resonance condition. A comparative study of double irradiation methods based on these effects has been carried out by applying them to the problem of resolving the 0.5-Hz splitting in the 60-MHz proton magnetic resonance spectrum of 3-bromothiophene-2-aldehyde, attributed to long-range spin coupling of the aldehyde proton with the ring proton at position 4. (auth)

7383 MULTIPHONON ORBIT–LATTICE RELAXATION IN $LaBr_3$, $LaCl_3$, AND LaF_3. Riseberg, L. A.; Moos, H. W. (John Hopkins Univ., Baltimore). Phys. Rev. Lett., 19: 1423-6(Dec. 18, 1967).

Results are reported of a systematic study of multiphonon orbit–lattice relaxation of excited states in $LaBr_3$, $LaCl_3$, and LaF_3, using a number of rare earth ions as probes. Excited-state lifetime and quantum efficiency measurements in the optical and near-infrared regions were performed at 4.2°K to determine the spontaneous multiphonon transition rates. (W.D.M.)

7384 NUCLEAR MAGNETIC RESONANCE OF ^{57}Fe IN DILUTE ALLOYS OF Fe. Mendis, E. F.; Anderson, L. W. (Univ. of Wisconsin, Madison). Phys. Rev. Lett., 19: 1434-8(Dec. 18, 1967).

The nuclear magnetic resonance spectra of the dilute alloy systems FeCo, FeNi, FePd, FeSn, and FeV were examined. The hyperfine distributions show satellites which are interpreted as due to ^{57}Fe atoms with an impurity atom as a third, fourth, or fifth nearest neighbor. Satellites due to ^{57}Fe atoms with an impurity atom as a nearest or second-nearest neighbor are not observed. A discussion of these results is presented. (auth)

7385 ON THE THERMAL AND OPTICAL BLEACHING OF X-RAY IRRADIATED $KClO_3$ CRYSTALS. Hovi, Vaino; Rasanen, Vilho (Univ. of Turku, Finland). Ann. Acad. Sci. Fenn., Ser. A VI, No. 228, 1-13(1967).

The correlation between the ultraviolet and infrared bands of x-irradiated $KClO_3$ in thermal and optical bleaching has been investigated spectrophotometrically in the wavelength region of 0.2 to 25 μ. The formation of perchlorate in thermal bleaching is detected on the basis of the infrared spectrum. From the infrared spectra, force constants are calculated for ClO^- and ClO_3^- ions. The methods for growing $KClO_3$ crystals are also discussed. (auth)

7386 F CENTERS IN GAMMA- AND REACTOR-IRRADIATED NaCl CRYSTALS. Ikeda, Massomi; Nishi, Masato (Hiroshima Univ.). Hiroshima Daigaku Kogakubu Kenkyu Hokoku, 15: No. 2, 91-101(Aug. 1967). (In Japanese).

F-coloring in Harshaw NaCl single crystals was measured under ^{60}Co gamma and reactor irradiations. The peculiar deformation of the line shape of F band was observed when NaCl crystals colored up to the later stages of the growth curve of F center by gamma rays or reactor radiations were further exposed to gamma rays for a short time. There was a decrease in the peak height of the F band, and a corresponding increase in the low-energy tail of the band. This effect depended on the dose rate of gamma irradiation and the concentration of F centers. It took two or three hours for the rapid partial recovery of this effect, which did not agree with the half-life of the F' center at room temperature. In the early stages of short-time gamma irradiation of reactor-irradiated crystals, growth of the F center was observed with the destruction of the complex centers. When the irradiation was continued, however, the F band stopped growing and began to be bleached. When irradiation time with gamma rays was prolonged, both F and R bands continued to grow in proportion to the irradiation doses and especially the growth of the R band was remarkable. (NSA of Japan)

7387 LINEWIDTH OF MOESSBAUER ABSORPTION. Heberle, J. (Argonne National Lab., Ill. Clark Univ., Worcester, Mass.). Nucl. Instrum. Methods, 58: 90-2(Jan. 1968).

The linewidth W has been computed for various absorber thicknesses. It is assumed that both the source and the absorbing material have the natural linewidth Γ. Then, for an absorber containing n nuclei (of the resonant species) per unit area, the formula $W = 2\Gamma(1 + 0.1288t + 4.733 \times 10^{-3}t^2 - 9.21 \times 10^{-4}t^3 + 3.63 \times 10^{-5}t^4)$ approximates the computed values, where $t = nf'\sigma_{res}$. The values of W given by this formula are accurate to better than 0.15% for $0 \leq t \leq 12$. (auth)

7388 PHOTOCONDUCTIVITY IN SOLIDS. Huynh Chanh Trung. Nucleus (Paris), 8: 303-12(1967). (In French).

Photoionization produced in solids is considered for the general case. The problem of photoconductivity is then analyzed and the quantum principles which govern it are derived. A theoretical development assembles the various equations which characterize the processes of photoionization and photoconductivity. (tr-auth)

7389 EFFECT OF NEUTRON IRRADIATION AT THE TEMPERATURE OF 80°K ON THE THERMAL CONDUCTIVITY OF Si. Seyfert, Peter (CEN, Grenoble, France). Compt. Rend., Ser. A and B, 265: 609-12(Sept. 4, 1967). (In French).

Neutron irradiation at 80°K (4.3×10^{17} cm^{-2}) decreases very strongly the low-temperature thermal conductivity of Si containing O_2 ($\approx 10^{18}$ cm^{-3}). This effect reaches a factor of 160 at 20°K. An important anneal stage is observed at approximately 140°K. (tr-auth)

7390 RESONANT PHONON SCATTERING IN COLORED SODIUM CHLORIDE CRYSTALS. Aldrich, R. E.; Burke, W. J.; McCarthy, K. A. (Tufts Univ., Medford, Mass.). Solid State Commun., 5: 899-903(Nov. 1967).

The thermal conductivity of both γ-irradiated and additively colored sodium chloride crystals containing OH^- ions was found to show two prominent resonances, one at a frequency of 1.6 cm^{-1} and the other at 17 cm^{-1}. The 1.6 cm^{-1} resonant frequency is explained by tunneling transitions calculated from a Devonshire model. A model is proposed for the 17 cm^{-1} resonant frequency in which one of the chloride ions in the region of the OH^- ion is replaced by a negative ion vacancy. (auth) (UK)

7391 GENERAL STRUCTURE FACTOR FORMALISM FOR INTERPRETING ACCURATE X-RAY AND NEUTRON DIFFRACTION DATA. Dawson, B. (CSIRO Chemical Research Labs., Melbourne). Proc. Roy. Soc. (London), Ser. A, 298: 255-63(May 2, 1967).

The interpretation of x-ray- and neutron-diffraction data in accurate studies of crystal and molecular structure requires the development of a new structure-factor formalism. The formalism normally employed in structure analysis fails to recognize antisymmetric features associated with nonspherical atomic charge distributions and with anharmonic components of the atomic vibration amplitudes. Both these antisymmetric

features can be incorporated readily in the analysis of diffraction data by using a general formalism involving complex atomic scattering factors and complex temperature factors. Some implications of the general formalism are discussed. Relations between atomic motions and static positions are considered in terms of equilibrium and time-averaged concepts, and the case of vibrational motion is cited to illustrate the relation of these concepts to the type of vibrational approximation employed in data analysis. The discussion is extended to general considerations of the atomic scattering powers, and approximations in the customary handling of these quantities are noted. (auth) (UK)

7392 QUANTUM MECHANICAL THEORY OF BARRIER CROSSING BY IONS IN SOLIDS. Sussmann, J. A. (Weizmann Inst. of Science, Rehovoth, Israel). J. Phys. Chem. Solids, 28: 1643-8(Sept. 1967).

The passage of a particle from one potential well to an adjacent well is treated by quantum mechanics, for all temperatures. Phonon-induced tunnelling, which is the predominant transition mechanism at low enough temperatures, is described in detail. At higher temperatures transitions through nonlocalized intermediate states become important. The expression for tunnelling through the barrier is shown to be valid only when the transitions inside one well are faster than the tunnelling. The same process is shown to lead also to the classical Arrhenius-type expression for passing above the barrier. It is further shown that when this condition of fast relaxation is not satisfied, the transition probability is still of the classical form but the pre-exponential factor depends on the coupling between phonons and the particle. (auth) (UK)

7393 NEUTRON DIFFRACTION DETERMINATION OF THE COHERENT SCATTERING AMPLITUDE OF Np AND THE POSSIBLE ANTIFERROMAGNETISM OF NEPTUNIUM DIOXIDE. Heaton, L.; Mueller, M. H.; Williams, J. M. (Argonne National Lab., Ill.). J. Phys. Chem. Solids, 28: 1651-4 (Sept. 1967).

Neptunium dioxide has been reported to be antiferromagnetic with a Néel temperature of 25°K, based on magnetic susceptibility and specific heat measurements. Neutron-diffraction patterns were obtained at 5.4°K and 78°K from two neptunium dioxide samples with oxygen to metal ratios of 1.93 and 2.034. The scattering amplitude of Np was determined to have a value of $1.055 \pm 0.010 \times 10^{-12}$ cm. No significant difference was observed between the 5.4°K and 78°K neutron-diffraction patterns of either sample. Assuming that neptunium dioxide is magnetically isostructural with uranium dioxide, the magnetic moment of each neptunium atom is less than 0.5 Bohr magnetons. (auth) (UK)

7394 NEUTRON DIFFRACTION STUDY OF NpO_2. Cox, D. E.; Frazer, B. C. (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem. Solids, 28: 1649-50(Sept. 1967).

A powder neutron-diffraction study of NpO_2 was made at 4.6°K. No long-range magnetic order could be detected, although Mössbauer, magnetic susceptibility, and specific heat measurements indicate that NpO_2 becomes antiferromagnetic below 25°K. If an ordered moment is present, the neutron data place an upper limit of approximately 0.4 μ_B per Np ion on its magnitude. The coherent scattering amplitude of ^{237}Np was measured and found to be $1.057 \pm 0.015 \times 10^{-12}$ cm. (auth) (UK)

7395 STUDY OF DIRECTIONAL EFFECTS IN THE TRANSMISSION OF 2-MeV PROTONS THROUGH A SILICON MONOCRYSTAL. Remillieux, J.; Samuell, J. J.; Sarazin, A. (Institut de Physique Nucleaire, Lyon). J. Phys. (Paris), 28: 832-8(Oct. 1967). (In French).

The channeling of 2-MeV protons through a silicon crystal is described. Axial channeling along [110], [111], [112], and [114] axes and planar channeling along (110) and (111) planes have been studied. The experimental anomalous transmission of the [110] axis has been calculated. Results are in good agreement with Lindhard's theory. Experimental results on the high-energy-loss component are given. The so-called "star patterns" have also been observed by a photographic method. (auth)

7396 INFRARED LATTICE VIBRATIONS OF SINGLE CRYSTAL LITHIUM HYDRIDE AND SOME OF ITS ISOTOPIC DERIVATIONS. Brodsky, M. H.; Burstein, E. (Univ. of Pennsylvania, Philadelphia). J. Phys. Chem. Solids, 28: 1655-68 (Sept. 1967).

The infrared reflection spectra of single crystal lithium hydride, lithium deuteride, lithium-6 hydride, and lithium-7 hydride were measured and analyzed. The long wavelength limits of the optical lattice vibrational frequencies were determined and used to find the static dielectric constants and Szigeti effective charges of all the isotopic variations studied. It was found that the square of the longitudinal (or transverse) frequency is inversely proportional to the reduced mass of the ion pairs forming the crystal. The Szigeti effective charge for LiH, $e_s^* = (0.53 \pm 0.02)e$, is qualitatively accounted for by the Dick and Overhauser shell model for the vibrating ions. A slight isotope effect on e_s^* was noted in LiD, and the difference in effective charges is interpretable within the framework of the shell model. (auth) (UK)

7397 MAGNETOCRYSTALLINE ANISOTROPY OF EUROPIUM SULFIDE. Franzblau, M. C.; Everett, Glen E.; Lawson, A. W. (Univ. of California, Riverside). Phys. Rev., 164: 716-19(Dec. 10, 1967).

The first- and second-order magnetocrystalline anisotropy constants, K_1 and K_2, of EuS were measured by a ferromagnetic resonance technique. The measurements were performed at 21.48 GHz and 1.35°K, and the sample was a small, highly polished strain-free single-crystal sphere, oriented so that the (110) plane contained both the rf and static magnetic fields. The linewidth was of order 10 Oe, the narrowest observed in a chalcogenide of europium and indicates the degree of perfection and purity of the sample. K_1/M and K_2/M (where M is the saturation magnetization) were determined to be -19.6 ± 1.0 and -4.6 ± 0.3 Oe, respectively. The cubic crystal-field splitting parameters b_4 and b_6 were calculated on the basis of Wolf's single-ion mechanism, and were determined to be $(0.268 \pm 0.014) \times 10^{-4}$ and $(-0.019 \pm 0.09) \times 10^{-4}$ cm^{-1}, respectively. The results are compared with the behavior of the Eu^{++} ion in cubic host lattices. (auth)

7398 β-URANIUM HYDRIDE: HEAT CAPACITIES FROM 1.4 TO 23°K AND SOME DERIVED PROPERTIES. Flotow, Howard E.; Osborne, Darrell W. (Argonne National Lab., Ill.). Phys. Rev., 164: 755-8(Dec. 10, 1967).

The heat capacity of the metallic, ferromagnetic compound β-UH_3 was determined from 1.4 to 23°K. An attempt was made to fit the data at the lowest temperatures by an equation of the form $C_p = \gamma T + AT^3 + BT^{\frac{1}{2}}$, where γT is the contribution of the conduction electrons, AT^3 is the lattice contribution, and $BT^{\frac{1}{2}}$ is the magnetic contribution. The coefficient γ is 29 ± 1 $mJ°K^{-2}$ $mole^{-1}$. Because of uncertainty in the magnetic contribution, no reliable estimate of A or of the Debye Θ could be made. The thermodynamic functions $S°$, $(H° - H_0°)/T$, and $(G° - H_0°)/T$ were reevaluated as 63.67 ± 0.13, 30.24 ± 0.06, and -33.43 ± 0.07 J (°K mole)$^{-1}$, respectively, at 298.15°K. (auth)

7399 ANALYSIS OF DEBYE-WALLER FACTOR AND MOESSBAUER THERMAL-SHIFT MEASUREMENTS. II. THERMAL-SHIFT DATA ON Fe. Housley, R. M. (North American Aviation Science Center, Thousand Oaks, Calif.); Hess, F. Phys. Rev., 164: 340-4(Dec. 10, 1967).

Techniques developed in a previous paper are used to subtract the second-order Doppler contribution from measured thermal shifts on pure Fe and dilute Fe in various hosts. This allows the temperature dependence of the isomer shift arising from the electron density at the nucleus to be seen more clearly than was previously possible. It is shown that this temperature dependence cannot be accounted for by thermal expansion alone. In pure Fe a contribution related to the magnetization is clearly evident, as is theoretically expected. A contribution in addition to this and the thermal-expansion contribution is present, contrary to the conclusion generally drawn from previous work. The additional contribution to the isomer shift is discussed in terms of two theories that have been used to explain the temperature dependence of hyperfine coupling constants. (auth)

7400 MOESSBAUER-EFFECT DETERMINATION OF THE CRYSTALLINE ELECTRIC FIELD PARAMETERS IN THULIUM METAL. Uhrich, D. L.; Barnes, R. G. (Ames Lab., Iowa). Phys. Rev., 164: 428-35(Dec. 10, 1967). (IS-1584).

By measuring the temperature dependence of the nuclear quadrupole splitting of the 8.42-keV Mössbauer transition in the paramagnetic state of thulium metal, a determination of the crystalline electric field (CEF) parameters of elemental thulium has been obtained. The nuclear quadrupole interaction was studied within the temperature range 59 to 156°K. It was found that a zero-order calculation was sufficient to fit theory to experiment, and that in particular only C_2^0, ρ_1, and ρ_2' (where the ρ's account for shielding constants and the temperature-independent contributions to the electric field gradient at the nucleus) were needed to fit the theory to the data. The remaining CEF parameters, C_4^0, C_6^0, and C_6^6, were constrained to equal zero in the fitting routine. The overall splitting of the $^3H_6$ ground multiplet was found to be 76.1 cm^{-1}. This study also includes a determination of electronic shielding factors for thulium. The atomic Sternheimer factor R_O was found to be 0.16; and the constant σ_2, which represents the shielding of the 4f shell from the CEF by the closed outer shells, was found to be 0.34. The latter quantity was obtained under the assumption that screening of the Tm^{+3} ions by the conduction electrons can be

neglected. The direct lattice contribution and the conduction-electron contribution to the net electric field gradient at the Tm nucleus were found to be positive and of the same order of magnitude. (auth)

7401 NUCLEAR MAGNETIC RESONANCE IN DILUTE Cu-Base Cu–Mn ALLOYS. Lumpkin, O. J. (Columbia Univ., New York). Phys. Rev., 164: 324-8(Dec. 10, 1967).

By studying the ^{63}Cu nuclear magnetic resonance in a series of Cu–Mn alloys at room temperature and at 4, 8, and 12.8 MHz, the long-range quadrupole interaction — in addition to the previously measured magnetic one — between copper nuclear spins and manganese impurities was estimated. Comparing wipeout numbers at 4 MHz, this interaction is about six times greater than the electric interaction measured in CuZn by Rowland. The measured size of the magnetic interaction and the calculated Ruderman–Kittel interaction were used to make an order-of-magnitude estimate of the impurity–impurity interaction. Also ^{63}Cu spin–lattice relaxation times have been measured as a function of dc field in a 10-ppM alloy at 1.3°K, using field cycling, and the field dependence indicates that the magnetic interaction is predominantly scalar exchange. Finally, Overhauser enhancement of the ^{63}Cu nuclear resonance was produced in the 10-ppM alloy at 1.3°K by applying 30- and 50-MHz rf to the sample in dc fields between 0 and 10 G. Both the temperature and the dc field dependence of this effect are puzzling, but the magnitude of the rf field needed suggests that the spin–lattice relaxation time of the localized impurity moment is longer than 10^{-3} sec at 1.3°K. (auth)

7402 ELEKTRONENTHEORIE DER METALLE. (Electron Theory of Metals). Sommerfeld, A.; Bethe, H. Heidelberger Tashenbuecher Bd. 19. Berlin, Heidelberg, New York, Springer-Verlag, 1967. 295p. DM 10.80; $2.70.

The hypothesis of the free electrons is derived. Electrons in periodic potential fields are discussed with a consideration of eigenvalues and eigenfunctions, statistics, effects that do not depend on the interaction with lattice waves, electrical conductivity, and complex effects. The metal as a whole is described. The eigenvalue is calculated and the concept of ferromagnetism is outlined. The cohesion force of metals is considered. (J.S.R.)

Theoretical Physics

Refer also to abstract 7637.

7403 (ITF–66-7) STATISTICAL MECHANICS OF IRREVERSIBLE PROCESSES. Shelest, A. V. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1966. 21p. Dep.

A kinetic equation for the density matrix of a small system was derived, based on an irreversible process in a system consisting of a subsystem and thermostat and assuming weak interactions between the two. The method did not use the hypothesis of phase disorder of the wave functions belonging to various eigenvalues of the Hamiltonian system. (tr-auth)

7404 (ORNL–4193) CONDUCTIVE SPHERE ON A CHARGED CONDUCTIVE PLANE. Fish, Birney Robert (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 72p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee [Knoxville].

The electrostatic problem of a conductive sphere on a charged conductive plane has been solved using theoretical and experimental methods. From elementary electrostatics it is seen that there will be a uniform electric field E_0 volts/meter normal to a semi-infinite plane bearing σ_0 coulombs/meter^2. Based on an image charge approach, it was determined that a sphere of radius R meters will acquire a total equilibrium charge $q = \frac{1}{3}\pi^3 R^2 \sigma_0$ coulombs at contact with the plane, and the uniform field will be perturbed, resulting in a field strength $E = 4.5E_0$ volts/meter at the top of the sphere. An approximation, valid to within less than about 1%, for the repulsive force acting on the sphere was obtained by extrapolating to contact, series solutions of the Laplace equation for finite separation between sphere and plane: the force at contact is estimated to be $F_z = 1.537 \times 10^{-10} kR^2 E_0^2$ newtons; where k is the dielectric constant of the surrounding medium. The charge distribution on the sphere was determined experimentally by plating copper on a sphere–plane cathode and, within about 10%, is given by the empirical expression $\sigma(\theta) = [0.8696 \cos(2\theta/2) + 3.6304 \cos(4\theta/2)]\,\sigma_0$; where θ is the angle of colatitude in spherical polar coordinates referred to the axis of contact and concentric with the sphere. (auth)

7405 NUMERICAL SOLUTION OF THE QUASILINEAR POISSON EQUATION IN A NONUNIFORM TRIANGLE MESH. Winslow, Alan M. (Lawrence Radiation Lab., Livermore, Calif.). Contract W-7405-eng-48. J. Comput. Phys., 2: 149-72(Nov. 1966). (UCRL–7784-T(Rev.2)).

A finite-difference method using a nonuniform triangle mesh is described for the numerical solution of the nonlinear two-dimensional Poisson equation $\nabla \cdot (\lambda \nabla \varphi) + S = 0$, where λ is a function of φ or its derivatives, S is a function of position, and φ or its normal derivative is specified on the boundary. The finite-difference equations are solved by successive overrelaxation. The triangle mesh, which is constructed numerically by solving Laplace's equation, is easily adapted to nonrectangular boundaries and interfaces. Examples of numerical results are given for the magnetostatic problem with iron, and other possible applications are mentioned. (auth)

7406 FINITE TRANSLATIONS IN SOLID-STATE PHYSICS. Zak, J. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 19: 1385-7(Dec. 11, 1967).

Eigenvalues of finite translations are used for specifying a complete set of states in quantum mechanics. A derivation of these states is given and they are shown to be very useful in solid-state physics. (auth)

7407 GREEN'S TEMPERATURE FUNCTIONS FOR A SLIGHTLY NONIDEAL BOSE–EINSTEIN SYSTEM. Tolmachev, V. V. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 175: 800-3(Aug. 1, 1967). (In Russian).

Previously the author constructed the theory of elementary excitations of temperature similar to the Fermi theory of excitation with long-range interactions. Following this, P. Hohenberg (Excitation of Dilute Bose Gas, Thesis, Harvard Univ., 1962) showed that at temperature $\theta = 0$ and small interactions, the special collective spectral branch discussed by the author, could not exist. Data obtained by the author in his present work confirm P. Hohenberg's postulation and expand the theory offering some new data. (R.V.J.)

7408 PRACTICAL POINTS CONCERNING THE SOLUTION OF THE SCHROEDINGER EQUATION. Blatt, John M. (Hebrew Univ., Jerusalem). J. Comput. Phys., 1: 382-96(Feb. 1967).

In calculations of molecular energy levels of the quarkium molecule ion, it proved necessary to solve the one-dimensional (radial) Schroedinger equation many times over, for different values of the vibrational quantum number N (= number of nodes in the radial wave function) and of the angular momentum number L. Solutions to the following problems are discussed: (1) How to choose a step size, how to decide when the step size needs changing, and how to carry out this change. In this connection, a midpoint formula was developed for use with the Noumerov method. (2) How to iterate on the eigenvalue when already close to it. The usual variational method was put into a convenient form, and a formula was developed for the derivative of the wave function, to be used with the Noumerov method (it was noted that the Nuomerov method itself does not give the derivative at all). (3) How to narrow down the search for the desired eigenvalue (given number of nodes N) in the initial stages. (4) How to decide on a practical range of the independent variable x (or r) for the numerical integration. All these processes, many of them involving choices, were to be carried out by the machine, without operator intervention during the course of the computation. (BBB)

7409 SYMMETRY ORIGIN OF DYNAMICS. Greenberg, David F. (Univ. of Chicago). Contract AT(11-1)-264. Amer. J. Phys., 35: 1073-7(Nov. 1967). (COO–264-317; EFINS–66-33).

Examples from classical mechanics are used to illustrate a procedure by which dynamical information may be extracted from experimentally observed higher symmetries. Broken symmetries are also discussed. (auth)

7410 LOWER BOUNDS FOR THE BINDING ENERGIES OF N-PARTICLE SYSTEMS. Pruski, S. (Nicholas Copernicus Univ., Torun, Poland). Can J. Phys., 45: 3753-60(Nov. 1967).

Two new families of lower bounds to the energy of an N-fermion system interacting via two-body forces are derived. They involve, respectively, energy levels of (N – 1)- and (N – 2)-particle systems associated with the given N-fermion system. The first is expected to give a fairly close approximation to the energy. In the case of an atom of nuclear charge Z with N electrons, the ground-state energy of this [Z, N] ion is bounded below by $(N-1)/(N-2)^2$ times the sum of the N lowest energy levels of an associated ion [Z′, N′], with $N' = N - 1$ and $Z' = Z(N-2)/(N-1)$. (auth) (CANADA)

7411 DIELECTRIC CONSTANT OF A DENSE ELECTRON GAS CONTAINING A FIXED POINT CHARGE. Tripathy, D. N. (Saha Inst. of Nuclear Physics, Calcutta). Phys. Rev., 164: 582-90(Dec. 10, 1967).

An expression for the dielectric constant of a dense electron gas containing a positive point charge Ze with a neutralizing positive background is obtained by employing the diagram technique of quantum field theory. The present derivation leads to some more terms in addition to those obtained in the self-consistent-field approximation. Besides, the derivation rigorously takes into account the Pauli exclusion principle. The simplest evaluation of the dielectric constant is made in the region where collective effect dominates, and the results are compared with those obtained in self-consistent-field approximation. (auth)

7412 SOME EXACT RESULTS FOR THE MANY-BODY PROBLEM IN ONE DIMENSION WITH REPULSIVE DELTA-FUNCTION INTERACTION. Yang, C. N. (State Univ. of New York, Stony Brook). Phys. Rev. Lett., 19: 1312-15(Dec. 4, 1967).

The repulsive δ interaction problem in one dimension for N particles is reduced, through the use of Bethe's hypothesis, to an eigenvalue problem of matrices of the same sizes as the irreducible representations R of the permutation group S_N. For some R's this eigenvalue problem itself is solved by a second use of Bethe's hypothesis, in a generalized form. In particular, the ground-state problem of spin-$\frac{1}{2}$ fermions is reduced to a generalized Fredholm equation. (auth)

7413 ON THE THEORY OF THE NONLINEAR COMPTON EFFECT. I. Kronig, R.; Pals, J. A. Kon. Ned. Akad. Wetensch., Proc., Ser. B, 70: 376-83(1967).

The scattering cross section for the quadratic Compton effect is computed in the case of plane polarized, monochromatic incident radiation. (auth)

7414 KINETIC ENERGY AS A PERTURBATION. I. Gammel, J. L.; Rousseau, C. C.; Saylor, Dwight P. (Texas A And M Univ., College Station). Math Anal. Appl., 20: 103-9(Oct. 1967).

In perturbation theory a parameter is introduced as a multiplicative factor in the potential and the wave function and energy of the system are expanded in powers of this parameter. It is uncertain whether the parameter can be introduced as a multiplicative factor in the kinetic energy instead. For wave functions sharply localized in space the kinetic energy must be infinite according to the uncertainty principle. Thus it appears that it is not appropriate to treat the kinetic energy as a perturbation. A method is investigated by which this difficulty can be overcome, and the usefulness of the resulting perturbation theory is evaluated. (J.F.P.)

7415 ON THE THEORY OF THE NONLINEAR COMPTON EFFECT. III. Kronig, R. Kon. Ned. Akad. Wetensch., Proc. Ser. B, 70: 389-91(1967).

The quadratic Compton effect is considered for the case of an incident plane electromagnetic wave containing two different frequencies. It is shown that the scattering of x rays can be increased by 100% or more if the scattering sample is simultaneously subjected to optical radiation of an intensity such as is furnished today by solid-state lasers. (auth)

7416 ON THE THEORY OF THE NONLINEAR COMPTON EFFECT. II. Kronig, R. Kon. Ned. Akad. Wetensch., Proc., Ser. B, 70: 389-91(1967).

The results obtained in part I for the scattering cross section in the quadratic Compton effect are extended to the case that the incident monochromatic wave has an arbitrary state of polarization. (auth)

7417 ENERGY–MOMENTUM TENSOR OF THE ELECTROMAGNETIC FIELD. de Teramond, Guy (Univ., Costa Rica). Compt. Rend., Ser. A and B, 265: 209-10(July 24, 1967). (In French).

The expression of the impulse-energy tensor introduced by S. Siansky is deduced by means of variation calculation from the Lagrange function of classic electrodynamics. (tr-auth)

7418 PSEUDOPOTENTIALE. (Pseudopotential). Gombas, P. Vienna, Springer-Verlag, 1967. 143p. $9.75.

A survey is given of the total range of the theory of pseudopotentials and their application. The principles of pseudopotentials are outlined. Exchange potentials, correlation potentials, statistical population-forbidden potentials, and nonlocal population-forbidden potentials are considered. (J.S.R.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Electromagnetic

Refer also to abstract 6642.

7419 (LAL-1181) A STUDY OF ELECTRON–POSITRON ANNIHILATION INTO $\pi^+\pi^-$ AT 775 MeV WITH THE ORSAY STORAGE RING. Augustin, J. E.; Bizot, J. C.; Buon, J.; Haissinski, J.; Lalanne, D.; Marin, P. C.; Perez-y-Jorba, J.; Rumpf, F.; Silva, E.; Tavernier, S. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Oct. 1967. 9p. Dep.

A preliminary measurement of the cross section for the reaction $e^+ + e^- \rightarrow \pi^+ + \pi^-$ at 775 MeV in the region of the ρ^0 is presented. Arrays of scintillation counters and spark chambers were used to detect 303 events of which 99 were $\pi^+\pi^-$ events and 102 were $e^+ + e^-$ events. Additional events were also obtained from a statistical analysis of the unidentified remaining events. Finally the ratio N_π/N_e was found to be 1.15 ± 0.19. The total luminosity and the total cross section are determined, and the $\rho^0 \rightarrow e^+ + e^-$ branching ratio is estimated. (J.F.P.)

7420 (LAL-1183) BACKWARD SCATTERING OF POSITRONS AND ELECTRONS ON PROTONS. Bouquet, B.; Benaksas, D.; Grossetete, B.; Jean-Marie, B.; Parrour, G.; Poux, J. P.; Tchapoutian, R. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Nov. 1967. 10p. Dep. CFSTI.

A new ratio measurement at 180° scattering is performed for electron and positron elastic scattering on protons. Following Gourdin's interpretation, it is hoped that the most accurate measurement of a possible two-photon exchange contribution can be obtained. Scintillation counters are used to detect the scattered leptons. Preliminary results are given. (J.F.P.)

7421 (SLAC–77) PHOTOPRODUCTION KINEMATICS TABLES FROM 0.5 TO 45 GeV. Busza, W.; Diebold, R.; Ecklund, S. (Stanford Linear Accelerator Center, Calif.). Oct. 1967. Contract AT(04-3)-515. 196p. Dep. CFSTI.

Kinematic quantities for two-body and quasi two-body photoproduction on protons are listed. Although the laboratory angle and momentum are given for both outgoing particles, differential quantities such as the solid angle transformation, Jacobians, etc., are given only for the long-lived charged particles (π^+, K^+, p); to this extent the tables are oriented toward spectrometer experiments. Each table is characterized by the laboratory photon energy and lists the various kinematic quantities every 5° in the cms from 0 to 180°. (J.F.P.)

7422 PARTIAL DECAY RATES OF THE η^0 MESON. Baltay, C. (Columbia Univ., New York. Brookhaven National Lab., Upton, N. Y.); Franzini, P.; Kim, J.; Kirsch, L.; Newman, R.; Yeh, N.; Cole, J. A.; Lee-Franzini, J.; Yarger, H. Phys. Rev. Lett., 19: 1498-1501(Dec. 25, 1967).

The ratios $(\eta^0 \rightarrow \text{neutral decay modes})/(\eta^0 \rightarrow \text{charged decay modes})$ and $(\eta^0 \rightarrow \pi^+\pi^-\gamma)/(\eta \rightarrow \pi^+\pi^-\pi^0)$ were measured to be, respectively, 2.64 ± 0.23 and 0.28 ± 0.04. By combining these ratios with previous results for the neutral modes, partial decay rates for the various η^0 decays. In particular, $(\eta^0 \rightarrow 3\pi^0)/(\eta^0 \rightarrow \pi^+\pi^-\pi^0) = 1.58 \pm 0.25$ was obtained, which is in good agreement with the assumption that the three-pion final state has I = 1. (auth)

7423 NEUTRAL DECAY BRANCHING RATIOS OF THE η^0 MESON. Baltay, C. (Columbia Univ., New York. Brookhaven National Lab., Upton, N. Y.); Franzini, P.; Kim, J.; Newman, R.; Yeh, N.; Kirsch, L. Phys. Rev. Lett., 19: 1495-8(Dec. 25, 1967).

The branching ratios for the decay of the η^0 meson into $3\pi^0$, $\pi^0\gamma\gamma$, and $\gamma\gamma$ have been measured. Under the assumption that no other neutral decays are significant, the results are $(\eta^0 \rightarrow 3\pi^0)/(\eta^0 \rightarrow \gamma\gamma) = 0.88 \pm 0.16$ and $(\eta^0 \rightarrow \pi^0\gamma\gamma)/(\eta^0 \rightarrow \gamma\gamma) \leq 0.28$ (95% confidence-level upper limit). (auth)

7424 MEASURABILITY OF THE PROTON ELECTRIC DIPOLE MOMENT. Sandars, P. G. H. (Oxford Univ.). Phys. Rev. Lett., 19: 1396-8(Dec. 11, 1967).

Calculations are presented which suggest that a suitable molecular-beam resonance experiment can form a sensitive test for the existence of an electric dipole moment on the proton. (auth)

7425 BRANCHING RATIO $\Gamma(\eta \rightarrow 3\pi^0)/\Gamma(\eta \rightarrow 2\gamma)$ MEASURED USING A 4π SPARK CHAMBER. Cence, R. J. (Univ. of Hawaii, Honolulu); Peterson, V. Z., Stenger, V. J.; Chiu, C. B.; Eandi, R. D.; Helmholz, A. C.; Kenney, R. W.; Moyer, B. J.; Poirier, J. A.; Richards, W. B. Contracts W-7405-eng-48; AT(04-3)-511. Phys. Rev. Lett., 19: 1393-5(Dec. 11, 1967).

A measurement was made of the branching ratio $R_1 = \Gamma(\eta \rightarrow 3\pi^0)/\Gamma(\eta \rightarrow 2\gamma)$, based on 4π spark-chamber observation of five- and six-shower events produced in $\pi^- + p \rightarrow \eta + n$ and other $\pi^- + p \rightarrow$ neutrals both below and above η threshold. R_1 was found to be 1.1 ± 0.2. (L.B.S.)

7426 FORWARD PEAK IN π^+-PHOTOPRODUCTION. Buschhorn, G.; Heide, P.; Koetz, U.; Lewis, R. A.; Schmueser, P.; Skronn, H. J. (Deutsches Elektronen-Synchrotron, Hamburg. Univ., Hamburg). Phys. Lett., 25B: 622-3(Nov. 27, 1967).

The π^+-photoproduction cross section is found to have a peak in the forward direction in disagreement with simple Regge pole models. (auth)

7427 OBSERVATION OF PHOTOPRODUCED NEUTRAL K MESONS. Schivell, J. F. (Harvard Univ., Cambridge, Mass.); Engels, E. Jr.; Entis, A.; Paterson, J. M.; Hand, L. N.; Sadoff, A. Phys. Rev. Lett., 19: 1349-52(Dec. 4, 1967).

The initial results of a beam survey of K_L mesons photoproduced from a one-radiation length aluminum target are reported. The method used to detect the K_L's and the momentum spectrum obtained is discussed. (L.B.S.)

Weak

7428 (COO-1195-102) MEASUREMENT OF THE STRONG INTERACTION FORM FACTOR AND THE CHARGE ASYMMETRY IN THE DECAY $K_2^0 \rightarrow \pi \pm e \pm \nu(\bar{\nu})$. Verhey, Lynn James (Illinois Univ., Urbana). 1968. Contract AT-(11-1)-1195. 135p. Dep. CFSTI.

A set of shower spark chambers was used to measure the energy dependence of the strong interaction form factor and the charge asymmetry in the decay $K_2^0 \rightarrow \pi^+ + e^- + \nu$ and $K_2^0 \rightarrow \pi^- + e^+ + \bar{\nu}$. The comparison of the cms meson (π) spectrum obtained in the experiment with the various predictions of the Monte Carlo calculation gives results for the parameters describing the energy dependence of the strong interaction form factor for two different assumptions about the form of this energy dependence. An investigation of the ratio of $\pi^+ + e^- + \nu$ final states to $\pi^- + e^+ + \bar{\nu}$ final states gives the result 0.935 ± 0.062. This result agrees reasonably well with no charge asymmetry. (J.F.P.)

7429 (LA–3780) EXPERIMENTAL DETERMINATIONS OF HALF-LIVES OR MEAN LIVES OF FREE PIONS AND MUONS. A Literature Search. Furnish, Jean (comp.) (Los Alamos Scientific Lab., N. Mex.). July 26, 1967. Contract W-7405-eng-36. 19p. Dep. CFSTI.

A search was made for abstracts relating to experimental determinations of half-lives or mean lives of free mesons (π) and mesons (μ). This search was made in Nuclear Science Abstracts, Vol. 5 (1951) through Vol. 21 No. 12 (June 30, 1967). The abstracts are arranged in rough chronological order by year with the most recent given first. (J.F.P.)

7430 NEW EXPERIMENTAL LIMIT ON $\Delta S = -\Delta Q$ LEPTONIC DECAYS OF Σ^+ HYPERONS. Baggett, N.; Day, T. B.; Glasser, R. G.; Kehoe, B.; Knop, R.; Sechi-Zorn, B.; Snow, G. A. (Univ. of Maryland, College Park). Phys. Rev. Lett., 19: 1458-60 (Dec. 18, 1967).

No $\Sigma^+ \rightarrow n + l^+ + \nu$ decay was found in a rapid scan of 550,000 hydrogen bubble chamber pictures exposed to a stopping K^--meson beam. Based on the 260 $\Sigma^- \rightarrow n + l^- + \bar{\nu}$ events found in the same scan, the upper limit (90% confidence level) for the ratio of Σ^+ to Σ^- leptonic decay rates is 0.034. (auth)

7431 TWO-PION DECAY OF THE LONG-LIVED K^0 AT 10.7 GeV/c. De Bouard, X.; Dekkers, D.; Jordan, B.; Mermod, R.; Scharff, B.; Valentin, L.; Vivargent, M.; Willitts, T. R.; Winter K.; Bott-Bodenhausen, M. (CERN, Geneva). Nuovo Cim. (10), 52A: 662-76(Dec. 1, 1967).

The decay rate of K_L^0 into $\pi^+\pi^-$ was measured at a mean K_L^0 momentum of 10.7 GeV/c with the aim to search for an energy dependence. The branching ratio of this decay mode as compared to charged decay modes found in this experiment is $(2.12 \pm 0.18) \cdot 10^{-3}$ in agreement with other results of $(1.97 \pm 0.16) \cdot 10^{-3}$ at 1.1 GeV/c and $(2.08 \pm 0.16) \cdot 10^{-3}$ at 2.5 GeV/c. This result excludes the possibility to maintain CP invariance by introducing a new long-range vector field. From a fit to the branching ratios at different K_L^0 momenta an upper limit was obtained on an energy splitting between K^0 and $\bar{K}^0$ due to gravitational effects of $1 \cdot 10^{-30}$ $m_K c^2$ with 90% confidence. (auth)

7432 A SEARCH FOR LEPTON NONCONSERVATION IN DOUBLE BETA DECAY WITH A GERMANIUM DETECTOR Fiorini, E. (Univ., Milan. INFN, Milan); Pullia, A.; Bertolini, G.; Cappellani, F.; Restelli, G. Phys. Lett., 25B: 602-3 (Nov. 27, 1967).

A new technique is applied to the search for neutrinoless double β decay. A Ge(Li) crystal is used both as source and as detector of the $^{76}Ge \rightarrow {}^{76}Se$ transition. The negative result ($\tau_{\frac{1}{2}} > 3 \times 10^{20}$ y) is consistent with the lepton conservation law. (auth)

7433 STUDY OF π^+, γ ANGULAR DISTRIBUTION IN THE DECAY $K^+ \rightarrow \pi^+\pi^0\gamma$. Wolff, B.; Aubert, B. (Faculte des Sciences, Orsay, France). Phys. Lett., 25B: 624-6(Nov. 27, 1967).

In a sample of 1,400,000 K^+ decays in heavy liquid bubble chamber, a search was made for $K^+ \rightarrow \pi^+\pi^0\gamma$ events with 3 materialized γ's, in order to study (π^+,γ) angular distribution. The result favors constructive electric dipole internal bremsstrahlung interference in this mode, but remains compatible with dominant internal bremsstrahlung. (auth)

Strong (Baryon-Induced)

Refer also to abstract 7679.

7434 (BNL-11980) STUDY OF pp INTERACTIONS AT 28.5 GeV/c IN TWO- AND FOUR-PRONG FINAL STATES. Connolly, P. L.; Ellis, W. E.; Hough, P. V. C.; Miller, D. J.; Morris, T. W.; Ouannes, C.; Panvini, R. S.; Thorndike, A. M. (Brookhaven National Lab., Upton, N. Y.). [1967]. 43p. (CONF-671122-1). Dep. CFSTI.

From Conference on Interdisciplinary Discussion of Solid State Dosimetry, Seattle, Wash.

An analysis was made of 12,000 two-prong and 12,000 four-prong events from pictures of 28.5 GeV/c pp interactions in a hydrogen bubble chamber. Effective mass distributions in various channels are examined for both well-known and possible new enhancements or resonances. Momentum-transfer distributions and angular correlations for decaying isobars are also presented and cross sections are listed for various final states. The 1238 isobar appears strongly in most channels, the $p\pi^-$ effective mass from $p + p \rightarrow p + p + \pi^+ + \pi^-$ shows three bumps, and the $p\pi^+\pi^+$ effective mass in $p + p \rightarrow p + n + \pi^+ + \pi^+ + \pi^-$ shows some indication of an enhancement at about 1650. No obvious ρ enhancement is seen, but the ω^0 is predominantly produced in $\pi^+\pi^-\pi^0$ in the reaction $p + p \rightarrow p + p + \pi^+ + \pi^- + \pi^0$. (J.F.P.)

7435 (ITEF-477) ISSLEDOVANIE UPRUGOGO p-d-RASSEYANIYA NA BOL'SHIE UGLY V OBLASTI ENERGII 1-3,5 GeV. (A Study on p-d Elastic Scattering at Large Angles in the Energy Interval of 1 to 3.5 GeV). Bayukov, Yu. D.; Birger, N. G.; Borisov, V. S.; (and others) (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1966. 8p. (In Russian). Dep.

Differential cross-sections of p-d elastic scattering at large angles (Θ c.m. $\gtrsim 150°$) were measured in the energy interval 1-3.5 Gev. Results are compared with pole model predictions. (auth)

7436 EMISSION OF FAST DEUTERONS IN VERY LARGE STARS INDUCED BY 9 GeV PROTONS IN NUCLEAR EMULSION. Ciok, P.; Soltan, M.; Soltynski, K. (Inst. of Nuclear Research, Warsaw). Acta Phys. Pol., 32: 635-40(1967).

Emission of deuterons of momenta from 520 MeV/c to 720 MeV/c in 102 very large stars ($N_h \geq 28$, N_h—number of heavily ionizing particles per star) in nuclear emulsion was investigated. The stars belonged to the extreme class of interactions of 9 GeV protons with heavy nuclei in emulsion (predominantly Ag) corresponding to large energy transfer to the target nucleus. The interactions resulted in the rapid breakup of the nucleus into many nuclear particles. A large abundance of deuterons in the considered momentum interval was observed (1.6 ± 0.3 per star). The results are compared with those obtained previously in the study of other types of interactions and are interpreted in terms of the Butler–Pearson mechanism. (auth)

7437 HYPERFRAGMENT PRODUCTION IN Σ^--AT-REST CAPTURE STARS. Mora, S. (Istituto di Fisica dell' Univ., Parma, Italy) Nuovo Cim. (10), 52A: 800-6(Dec. 1, 1967).

The production of hyperfragments from emulsion nuclei which have captured a Σ^--hyperon is studied. One gives evidence that about 90% of these hypernuclei are produced in light nuclei such as ^{12}C, ^{14}N, ^{16}O. Moreover a production model is suggested, and a comparison is made between the experimental data and the predictions of the model. (auth)

7438 FREQUENCY DISTRIBUTION OF HEAVY PRONGS FROM HIGH-ENERGY STARS IN NUCLEAR EMULSIONS. Friedlander, E. M. (Inst. of Atomic Physics, Bucharest); Friedman, A. Nuovo Cim. (10), 52A: 912-17(Dec. 1, 1967).

Observations on about 11,000 stars produced by proton and meson (π) beams in emulsion stacks are reported. An analysis of these data and also previous data (about 15,000 events) reveal some regularities of the N_h distribution. The integral frequency distribution of N_h is given for protons. (J.F.P.)

7439 A STUDY OF MULTIPLE PRODUCTION IN NUCLEAR EMULSION IRRADIATED IN ACCELERATORS. Rybicki, Kryzyszof (Inst. of Nuclear Research, Krakow). Postepy Fiz., 18: 523-37(1967). (In Polish).

The main results obtained from the study of multiple production in nuclear emulsion irradiated in accelerators (i.e., interactions at proton energies up to 28 GeV and pion energies up to 18 GeV) are discussed. Methods of selection of interactions with free and quasi-free nucleons are examined. It appears that a number of grey tracks (recoil protons) gives the best selection of effective collisions with single nucleons of emulsion nuclei. Such selected events represent a significant fraction (about 40%) of all interactions in emulsion. For them Castagnoli's estimate of energy gives a good value after correction for the primary particle which survives collision and tends to conservation of both the primary direction and a large fraction (about 60%) of primary energy. Features of nucleon-nucleon and pion-nucleon collisions are described. A method of selection of interactions with various emulsion nuclei is given. It is shown that the intranuclear cascade and not the tunnel model properly describes proton-nucleus and pion-nucleus collisions at the energies under consideration. (auth)

Strong (Meson-Induced)

Refer also to abstracts 7425, 7438, and 7439.

7440 (COO-1195-45) THE REACTION $K^- + p \rightarrow K^- + p + \pi^+\pi^-$ AT 2.63 AND 2.70 GeV/c. Mortara, David Ward (Illinois Univ., Urbana). 1966. Contract AT(11-1)-1195. 72p. Dep. CFSTI.

Thesis.

An experiment was performed using the 72'' hydrogen bubble chamber with incident K^- beams of 2.63 and 2.70 BeV/c. In a film sample of 90,000 frames, 9307 4-prong, zero V^0 events were found and measured on SMP's. The events were fitted using the Berkeley analysis program, PACKAGE, and 1857 events were found to have a satisfactory kinematic fit to the reaction $K^-p \rightarrow K^-p\pi^+\pi^-$. This reaction was shown to be dominated by production of several known resonant states. A maximum likelihood fit shows that the final state consists of 32% N^{*++} $K^-\pi^-$, 26% $\overline{K}^*p\pi^-$, 12% $\overline{K}^*N^{*0}$, and 30% other miscellaneous states. Unexplained asymmetries are observed in the $\overline{K}^*$ and N^{*0} decay distributions for the $\overline{K}^*N^{*0}$ intermediate state. (auth)

7441 (ITEF-497) IZUCHENIE KHARAKTERISTIK A_2-MEZONA V π^-p VZAIMODEISTVII PRI IMPUL'SE 3,25 GeV/s. (A Study on the Characteristics of the A_2-Meson in the π^-p Interaction at a Pulse of 3.25 GeV/s). Vetlitskii, I. A.; Vladimirskii, V. V.; Grigor'ev, V. K.; (and others). (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1967. 24p. (In Russian). Dep.

Using the 55-cm hydrogen bubble chamber exposed to the π^--mesons beam at $3,25 \pm 0,02$ GeV/c 160,000 photographs were obtained and 2104 events of the reactions of the type $\pi p \rightarrow \pi p\pi^+\pi^-$ and 1766 events of the reactions type $\pi^-p \rightarrow \pi^-p\pi^+\pi^-\pi^+$ were selected and analyzed. In the spectrum of the effective masses of $\pi^+\pi^-\pi^-$ system from the first reaction A_2-mesons were selected and the analysis was made by the different methods to determine a spin-parity of this resonance. The second reaction was used to study $\pi\eta$-decay mode of the A_2-meson. (auth)

7442 (JINR-P1-3563) VZAIMODEISTOIYA π-MEZONOV S NUKLONAMI PRI IMPUL'SE 3.85 GeV/c. (Negative Pion–Nucleon Interactions at 3.85 GeV/c Momentum. Beznogikh, G. G.; Truskova, N. F.; Shakhbazyan, B. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 27p. (In Russian). Dep.

The results of investigations of negative pion–nucleon interaction at 3.85 GeV/c momentum using nuclear emulsions in strong magnetic fields are given. A pronounced asymmetry of secondaries in angular distributions in cms for three-prong events is revealed. This phenomenon can be due to coherent interaction processes of primary pions with nuclear substructures. (auth)

7443 THE LOWER LIMIT OF TRANSVERSE MOMENTUM AND FOUR-MOMENTUM TRANSFER OF RECOIL PROTONS IN HIGH-ENERGY INTERACTIONS OF SECONDARY PARTICLES

COMING FROM COSMIC-RAY JETS. Babecki, J. (Inst. of Nuclear Research, Krakow). Acta Phys. Pol., 32: 629-34(1967).

The transverse momenta and four-momenta of recoil protons were determined in the interactions of high-energy secondary cosmic-ray particles, a large fraction of which corresponds to π-nucleon interactions, and the result was compared with those obtained previously for nucleon-nucleon collisions. The method applied was based on the calculation of transverse momenta and four-momenta for all jet tracks assuming that a given track belongs to recoil proton and on further selection of the smallest possible value of $p_\perp$ and δ_2. For secondary jets, as previously for primary ones, distributions of the smallest possible $p_\perp$ values of recoil protons were obtained, average $p_\perp$-values being considerably larger than those of pions. Accordingly the obtained values of four-momentum of recoil protons are also large, of the order of several GeV/c. (auth)

7444 LOW-ENERGY K^--α ELASTIC SCATTERING. Boyd, J. H.; Burnstein, R. A.; McComas, J. G.; Veirs, V. R.; Rosenblatt, G. (Illinois Inst. of Tech., Chicago). Phys. Rev. Lett., 19: 1405-9(Dec. 11, 1967).

The differential cross section for K^--α elastic scattering for K^- laboratory momenta in the interval 110 to 160 MeV/c was measured in a helium bubble chamber. The data, together with measurements of the total absorption cross section in the same region, were fitted with a partial-wave analysis involving s- and p-wave scattering with complex phase shifts. These parameters are used for predicting the expected results of a K-mesonic x-ray experiment, viz., that >98% of the K^- capture is from the 2P state. (auth)

7445 REAL PART OF THE ELASTIC π^-p SCATTERING AMPLITUDE IN THE COULOMB INTERFERENCE REGION AT 3.48 AND 6.13 GeV/c. Nomofilov, A. A.; Sitnik, I. M.; Slepets, L. A.; Strunov, L. P.; Zolin, L. S. (Joint Inst. for Nuclear Research, Dubna, USSR). JETP Lett. (USSR) (Engl. Transl.), 6: 65-7(Aug. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 546-50(Aug. 1, 1967).

The real part of the nuclear amplitude of elastic π^-p scattering was measured, using the effect of the interference of the Coulomb and nuclear interactions in the squared four-momentum transfer interval $1.22 \times 10^{-3} \leq -t \leq 4.22 \times 10^{-3}$ $(GeV/c)^2$. An analysis of the experimental data with the aid of the Bethe formula, derived within the framework of nonrelativistic quantum mechanics, yields values $\alpha_B = (ReA_{nuc}/ImA_{nuc}) = -(0.17 \pm 0.7)$ at 3.48 GeV/c and $\alpha_B = -(0.22 \pm 0.09)$ at 6.13 GeV/c. Reduction of the same data in accord with the Solov'ev formula, derived on the basis of relativistic quantum field theory, yields the values $\alpha_S = -(0.12 \pm 0.07)$ and $\alpha_S = -(0.17 \pm 0.09)$ at 3.48 and 6.13 GeV/c, respectively. It is found that the results of calculation by means of the dispersion relation and the values obtained in the experiment are in good agreement. (L.B.S.)

7446 π^--p INTERACTIONS AT 650 MeV. Femino, S.; Jannelli, S.; Mezzanares, F. (Univ., Messina, Italy. Istituto Nazionale di Fisica Nucleare, Messina, Italy). Nuovo Cim. (10), 52A: 892-902(Dec. 1, 1967).

The interactions of (650 ± 15) MeV π^- in a hydrogen bubble chamber were investigated. About 10^4 pictures were examined and 4561 events (1946 elastic, 1204 neutrals, 1315 single-pion production, 96 multi-pion production) were found along a $33.75 \cdot 10^3$ cm total track length. The values of the deduced cross sections are $\sigma(\pi^-p$, elastic) = (17.82 ± 0.70) mb, σ(neutrals) = (11.35 ± 0.54) mb, $\sigma(\pi^-\pi^0p)$ = (4.79 ± 0.26) mb, $\sigma(\pi^-\pi^+n)$ = (7.05 ± 0.34) mb, $\sigma(\pi^-\pi^+\pi^0n)$ = (0.71 ± 0.08) mb, $\sigma(\pi^-\pi^0\pi^0p)$ = (0.05 ± 0.02) mb, $\sigma(\pi^-\pi^+\pi^-p)$ = (0.05 ± 0.02) mb, σ(total) = (41.82 ± 0.15) mb. For the elastic events, the differential cross-section was fitted by a fifth-order polynomial of cos θ and also expanded in a sum of Legendre polynomials: it is deduced that the higher azimuthal states, up to F_3, are present. For the single-pion production the effective mass distributions were compared with the Olsson-Yodh isobar model predictions. The agreement with the model is not very satisfactory for the enhancements in the mass effective spectra of the $\pi^+\pi^-$, $\pi^-\pi^0$, di-pion channels nor for the cms angular distributions. (auth)

7447 THE PRODUCTION OF STRANGENESS ZERO MESONS IN MULTIBODY FINAL STATES IN 6 GeV/c K^-p INTERACTIONS. Allison, W. W. M. (Oxford Univ.); Cruz, A.; Schrankel, W.; (and others). Phys. Lett., 25B: 619-21(Nov. 27, 1967).

A strong peak in the three pion mass spectrum is seen at the mass of the A1(1080) in two different final states. Evidence is also given for the production of a very narrow three pion resonance in the region of the δ(965). (auth)

7448 FORWARD AND BACKWARD $\pi^- + p \rightarrow K^0 + \Lambda^0/\Sigma^0$ AT 4 GeV/c. Hoang, T. F. (Argonne National Lab., Ill.); Kim, Y. S.; Margulies, S.; Groves, T. H. Phys. Lett., 25B: 615-18 (Nov. 27, 1967).

The angular distributions near 0° and 180° of associated production $\pi^- + p \rightarrow K^0 + \Lambda^0/\Sigma^0$ were measured at 4 GeV/c. The slope of the backward peak is about ¼ that of the forward peak, and the polarization of the forward Λ^0's is small. (auth)

7449 EVIDENCE FOR A_1^0 PRODUCTION IN K^-p INTERACTIONS AT 4.6 AND 5.0 BeV/c. Juhala, R. E. (Ames Lab., Iowa); Leacock, R. A.; Rhode, J. I.; Kopelman, J. B.; Libby, L. Marshall; Urvater, E. Phys. Rev. Lett., 19: 1355-9(Dec. 4, 1967). (IS-1673).

Approximately 5800 measured four-prong events from 60,000 frames of K^- interactions in hydrogen in the BNL 80-inch bubble chamber were processed to obtain a 1305-event sample for the reaction $K^-p \rightarrow K^-\pi^-\pi^+p\pi^0$. Evidence is presented for the observation of a $\rho^+\pi^-$ enhancement at 1060 ± 15 MeV with a width of 120 ± 15 MeV in the reaction at incident K^- momentum of 4.6 and 5.0 GeV/c. This is interpreted as the A_1^0 on the basis of mass, width, and decay modes. Also, the experimentally determined spin and parity for this effect are consistent with previous investigations of the charged A_1. (L.B.S.)

7450 INVESTIGATION OF A BOUND STATE (Σ^-n). Annoni, H.; Baumann, G.; Gerber, J. P. (Centre de Recherches Nucleaires, Strasbourg). J. Phys. (Paris), 28: 761-4(Oct. 1967). (In French).

A study of a possible (Σ^-n) bound state was made with a nuclear emulsion exposed to stopping K^- mesons. In a sample of 30 analyzed Σ^- hyperons no evidence of such a bound state was found. (auth)

Particle Interactions and Properties (Theoretical)

General

7451 (INFN/AE-66/6) CERN, TRIESTE HIGH ENERGY GROUP SEMINARS. VOLUME I. Fidecaro, G. (ed.) (Istituto Nazionale di Fisica Nucleare, Trieste (Italy)). Sept. 7, 1966, 150p. (In English and Italian). Dep.

Separate abstracts were prepared for four of the five papers presented. (W.H.K.)

For abstracts of individual papers see: 6641, 7492, 7528, and 7570.

7452 OPTIMUM PROBLEM OF LAGRANGE IN THE COMPOSITE MODEL OF ELEMENTARY PARTICLES. Lebedev, L. E. Izv. Vyssh. Ucheb. Zaved., Fiz., No. 8, 93-8(1967). (In Russian).

The static variant of the compound Fermi model was examined. The second variation principle, which induces the Lagrange problem of the nonclassical types and removes the states with definite energy, was introduced. The solution of the problem makes it possible to determine: the intensities of interaction; basic states of the class of fermions as functions of the radius of the strong interactions. The connection between the energy of the field system and the collection of the invariants of the general Lorentz group was established. This connection can be used as the basis of classification and leads to a new representation of the possibility of the origin of baryon and lepton charges. The problem was solved by direct methods in the space of singular spins. The final condition does not appear obligatory. (tr-auth)

7453 FIVE-DIMENSIONAL RELATIVISTIC SCHEME. Pyt'ev, Yu. P. I. Vestn. Mosk. Univ., Ser. III Fiz. Astron., No. 2, 102-8(Mar.-Apr. 1966). (In Russian).

An earlier concept concerning the representation of classical particles, considered as having been generated by fields, is further developed, comparing it to the singular solution of the field equation. Under the specified conditions, the kinematics of singularity coincides with the kinematics of particles. The total speed of the particle-singularity in the $x^{1\text{to}4}$ space was found to be equal with the limiting velocity c, regardless whether the particle is free or is located in an external field. The physical meaning of the $x^{0\text{to}4}$ five-dimensional space was examined for the simplest case, assuming that no electromagnetic and gravitational fields are involved. Study of the behavior of free particles revealed that their rest mass depends on the status of the motion of the observer. Examination of the decay of the particle indicated that the life time is related to the rest mass. When distance measurements and time coincidence in the proposed relativistic scheme was investigated, it was found that no information concerning the fifth coordinate is obtained by means of photons. (TTT)

7454 de SITTER MODEL FOR ELEMENTARY PARTICLES WITH NONSTATIC FRAME. Prasad, R. (Institut Henri Poincare, Paris). Nuovo Cim. (10), 52A: 972-80 (Dec. 1, 1967).

In the discussion of the de Sitter model for elementary particles with a nonstatic frame the connection between the internal and external fields is established by requiring that the external eigenvalue spectrum be the same as the internal one that is $\lambda_e = \lambda_i$. (J.F.P.)

7455 RELATIONSHIPS BETWEEN THE MASSES OF SUBATOMIC PARTICLES. Lewis, D. T. (Lab. of Government Chemist, London). Nature, 216: 784-6(Nov. 25, 1967).

This communication is an extension of the author's previous communication (Nature 216: 573 (1967)) in which a "tamaid" particle was proposed, of bound rest mass 25.95 MeV, in conjunction with a series of quantum numbers, to explain the masses of sub-atomic particles. The possible existence of another mass-energy entity (b) is now postulated, which, in association with the "tamaid," could be employed to build up units of matter corresponding to all known muons, mesons, baryons, etc. It is proposed to call this subsidiary entity a "bach." Present calculations suggest that the particle has a bound rest mass of 0.3263 MeV, smaller than the electron (0.511 MeV) and associated with a larger De Broglie wave-length. If the "bachs" and "tamaids" really constitute the ultimate particles of matter, it must be assumed that all subatomic particles consist essentially of a core of "tamaids" associated with a mass-energy aura, or field, of "bachs," whose physical form of natural existence is not easy to visualise. The problem of calculating the masses of charged subatomic particles is usually complicated by a lack of understanding of the fundamental relationships between mass and electrostatic charge, but these difficulties do not seem to militate against the direct application of the present theory to the computation of the masses of charged muons, baryons, etc. Stable structures are only achieved by the successive addition of packets of 13 particles. There appears to be encouraging support for the theory from the agreement of experimental and calculated values over a wide range of masses. The theory indicates clearly how uncharged particles differ from charged particles, and offers convincing reasons why the neutron should be heavier than the proton, whereas the $\overline{\Lambda}^+$ meson is heavier than the π^0 meson. The difference is essentially a result of the varying "bach" content of the sister particles, which nevertheless have the same overall "tamaid" content. If the wave mechanical concepts of Schroedinger are to be applied to the theory, the existence must be postulated of some form of attractive force between particles in equilibrium with the centrifugal forces produced in orbital states. It is stated that it should be possible by means of the theory to predict the probable nature of collisional events in a hydrogen bubble chamber, provided the accelerator beam is able to yield extra packets of mass-energy, E, to provide the "bachs" necessary to yield stable systems. It is for serious consideration whether the "bach" is in any way associated with the muonic neutrino. (UK)

7456 EMPIRICAL RELATION OF STABLE PARTICLE MASSES. Frosch, R. F. (Stanford Univ., Calif.) Nuovo Cim. (10), 52A: 677-83(Dec. 1, 1967).

It is pointed out that the masses of the stable particles ($\mu^{\pm}$, π^0, $\pi^{\pm}$, etc.) tend to be close to integral multiples of ($3m_e$), m_e being the electron mass. The probability for random mass values to cluster around integral multiples of ($3m_e$) as strongly as the experimental mass values is shown to be of the order of 10^{-3}. A procedure to search for other likely values of a "mass quantum" M_0 has been developed and is applied to mass values M_0 from 1.0 MeV to 100 MeV. In this range the strongest clustering of the stable particle masses around integral multiples of M_0 occurs for $M_0 = 2.9996\ m_e$. (auth)

7457 REMARKS ON THE EQUAL-TIME COMMUTATOR OF CURRENTS. Dietz, K.; Kupsch, J. (Univ., Bonn). Nuovo Cim (10), 52A: 918-23(Dec. 1, 1967).

A general discussion of equal-time current commutators is given. Only general properties of field theory such as locality, the spectrum condition, etc., when considering specific models, are defined only by demanding covariance of certain retarded functions. In particular conclusions are not drawn from a Dyson or Jost-Lehman representation. The case of both conserved and nonconserved currents is discussed. (J.F.P.)

7458 THEORY OF UNIVERSAL PRIMARY INTERACTIONS. Sudarshan, E. C. G. (Syracuse Univ., N. Y.). Nature (London), 216: 979-81(Dec. 9, 1967). (NYO-3399-127).

This theory originates from observations that the theory of particle interactions becomes much simpler and more capable of correlating apparently unrelated phenomena if it is postulated that electromagnetism and weak interactions are not primary properties of the nucleons but are acquired by virtue of their interaction with vector and axial vector fields. (auth)

7459 STATISTICAL ANALYSIS OF THE HIGH-ENERGY JET SHOWERS. Shunichi, Hasegawa (Waseda Univ., Japan); Ogita, Naofumi. Waseda Daigaku Rikogaku Kenkyusho Hokoku, No. 36, 54-60(Sept. 1966). (In Japanese).

The angular distribution of the secondary particles of high energy jets of ICEF project are analyzed in a statistical manner by means of the OKITAC 5090 M computer. Various characteristic physical quantities concerning multiple meson production are obtained, by making use of the kinematics developed recently, and the general relation of these quantities with the incident energy of the jet are studied. The angular distribution of secondary particles is investigated on the basis of the fireball model using the χ^2-test. (auth)

7460 CARGESE LECTURES IN PHYSICS. VOLUME 1. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967. 437p. $12.00 (Paperback); $22.50 (Hardbound).

There were 12 lectures included. Separate abstracts were prepared for 11 lectures. One lecture was previously abstracted in NSA as 21: 44444. (J.F.P.)

For abstracts of individual sections see: 7233, 7461-7464, 7472, 7482, 7483, 7501, 7534, and 7535.

7461 THE WIGNER-WEISSKOPF METHOD. Bernstein, Jeremy (New York Univ., N. Y.). pp 29-53 of Cargese Lectures in Physics. Volume 1. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

The general problem treated by this method is described. The hydrogen atom is mentioned as an example, and several examples from particle physics are considered in detail. These include hydrogen states, strongly interacting vector mesons, positronium, and mesons (K). (J.F.P.)

7462 INTRODUCTION TO CURRENT ALGEBRA AND ITS APPLICATIONS. Meyer, Ph. (Univ., Paris). pp 85-123 of Cargese Lectures in Physics. Volume 1. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

Some aspects of current algebra are discussed including the motivation, the isospin group, the SU(3) group and its extensions, Schwinger terms, the Adler-Weisberger relation, the infinite-momentum limit, and strangeness-changing currents and the F/D ratio. Also sum rules for $k^2 \neq 0$ and nonzero momentum transfer, sum rules involving the commutator of two space components of currents, soft pion emission and the $|\Delta I| = \frac{1}{2}$ rule in $K \rightarrow 2\pi$ decay, and soft pion emission $K \rightarrow 3\pi$ decay are considered. (J.F.P.)

7463 PARTIALLY CONSERVED CURRENTS. Levy, Maurice (Univ., Paris). pp 257-74 of Cargese Lectures in Physics. Volume 1. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

Some of the problems involved in partially conserved axial vector currents combined with current algebra are briefly reviewed. Also with the help of field theoretic models, the relation between strong and weak interactions, implied by the PCAC hypothesis, is analyzed. (J.F.P.)

7464 TOPICS IN BOOTSTRAP THEORY. Brout, R. (Univ. Libre, Brussels). pp 401-31 of Cargese Lectures in Physics. Volume 1. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

A presentation of the dynamical elements behind the bootstrap idea is given. A summary of the more conventional approach to bootstrap theory is presented with particular emphasis on the methods first put forth by Zachariasen and Zemach. Then the possible field theoretic foundations of the bootstrap hypothesis is explored using the Bethe-Salpeter equation. Some applications of the bootstrap theory to the domain of elementary particles are also considered. (J.F.P.)

7465 THEORY OF GROUPS IN CLASSICAL AND QUANTUM PHYSICS. VOLUME ONE. MATHEMATICAL STRUCTURES AND THE FOUNDATIONS OF QUANTUM THEORY. Kahan, Theo. New York, American Elsevier Publishing Co., Inc., 1966. 587p. $37.50.

Translation of Theorie des Groupes en Physique Classique et Quantique. Volume One. Structures Mathematiques et Fondements Quantiques by H. Ingram.

A comprehensive yet detailed view of group mathematics is given in all its applications to the different disciplines of theoretical physics and chemistry from crystallography to elementary particle theory by way of theories of atoms, molecules, nuclei, solids, etc. An exposition of group theory in the framework of axiomatized mathematics, the inhomogeneous Lorentz group, ab-

stract theory of groups, the theory of representations, the permutation group, axiomatics of quantum mechanics in relation to group theory, and rotation groups are considered. (J.F.P.)

Electromagnetic

Refer also to abstract 7494.

7466 (ITEF-493) ON THE TOTAL ANNIHILATION CROSS SECTION OF ELECTRON–POSITRON PAIRS INTO HADRONS AT HIGH ENERGIES. Gribov, V. N.; Ioffe, B. L.; Pomeranchuk, I. Ya. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1967. 8p. Dep.

The asymptotic behavior of the total cross section of the $e^+ + e^- \rightarrow$ hadrons at high energies is investigated. It is shown that at high $E\sigma \sim \text{Const}/E^2$, where E– are the energies of e^+ and e^- in cms. (auth)

7467 (MIT-3828-1) SEARCH FOR FERROMAGNETICALLY TRAPPED DIRAC MONOPOLES OF COSMIC RAY ORIGIN. Technical Progress Report. Kolm, Henry H. (Massachusetts Inst. of Tech., Cambridge. National Magnet Lab.). Nov. 2, 1967. Contract AT(30-1)-3828. 7p. (CONF-670328-1). Dep. CFSTI.

From Conference on the Application of Physics to the Earth and Planetary Interiors, Newcastle-upon-Tyne, England.

Progress is reported on the search for magnetic monopoles in ferromagnetic materials. The refinement of the apparatus to a confidence level adequate to ensure detection of a single monopole of charge greater than one sixth the charge predicted by Dirac, and mass greater than one tenth atomic mass unit, is reported. (L.B.S.)

7468 COMMENTS ON $\gamma_{\text{polarized}}\ N \rightarrow \pi\Delta$. Beder, Douglas S.; Soeding, Paul (California Univ., Berkeley. Lawrence Radiation Lab.). Aug. 10, 1967. Contract W-7405-eng-48. 29p. Dep. CFSTI.

Expressions are given for the production and decay angular correlations in the reaction $\gamma p \rightarrow \pi\Delta$ [with $J^P(\Delta) = 3/2^+$] with polarized photons. The use of this reaction to determine properties of s-channel baryonic resonances is discussed. The results are illustrated by examples showing which information can be obtained, in particular in the 1450-MeV and 1680-MeV resonance regions, with polarized (or unpolarized) photon beams. (auth)

7469 RADIATIVE CORRECTIONS IN β DECAY. Schwinger, Julian (State Univ. of New York, Stony Brook). Phys. Rev. Lett., 19: 1501-3(Dec. 25, 1967).

The close connection between the radiative correction to β-decay coupling and the ρ electromagnetic mass splitting is emphasized. It is shown that the introduction of the $\rho\gamma$ form factor not only solves the electromagnetic mass problem, but also removes the divergences produced by photon exchange with the electron in the β-decay coupling. (L.B.S.)

7470 POLARIZATION OF γ QUANTUM BREMSSTRAHLUNG DURING INELASTIC $\pi^+(K^+)-e$ SCATTERING. Mukhtarov, A. I.; R. Kh. (Inst. of Mathematics and Mechanics, USSR). Dokl. Acad. Nauk Azerb. SSR, 23: No. 4, 3-6(1967). (In Russian).

A circular polarization of bremsstrahlung in inelastic scattering of pseudoscalar $\pi^+(K^+)$ mesons on electrons ($\pi^+(K^+) + e \rightarrow \pi^+(K^+) + e + \gamma$ was studied with the case in which the quantum is emitted by electrons and by $\pi^+(K^+)$ mesons. In the examined case the contribution of $\pi(K)$ mesons on γ-quantum polarization is negligible and photon spirality is mostly determined by the electrons as in purely fermion–photon interactions γ-quanta have a maximum circular polarization while the photons are emitted parallel to the electron spin or when electrons transmit completely their spirality to the photons. It was concluded that experimental measurements of the circular polarization of γ quanta can be used for determining the degree of initial electron polarization. (R.V.J.)

7471 PHOTOPRODUCTION OF HEAVY MESONS ON NUCLEI NEAR THRESHOLD. Tsarev, V. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz., 6: 649-50(Sept. 1967). (In Russian).

The region of photon energies between the thresholds of photoproduction on a nucleus $E_m = \mu + \mu^2/2M$ and on a nucleon $E_m = \mu + \mu^2/2N$ is of interest (here μ, N and M are the masses of the meson, nucleon and the nucleus) in order to discover the internal motion of nucleons in the nucleus. The difference between thresholds is about 150 MeV for the η-meson, while it is ~10 MeV for π-mesons. The elastic reaction, which plays a substantial role for π-mesons, is considerably suppressed in the case of the heavy mesons (η, ρ^0, ω...). In estimating the cross section of the direct inelastic process a simple model of photoproduction on a quasifree nucleon moving with momentum p is assumed. An expression is obtained for the cross section as a function of the energy and angle of emission of the meson near the threshold of the reaction. (TTT)

7472 ELECTROPRODUCTION. Perez Y Jorba, J. (Laboratoire de l'Accelerateur Lineaire, Orsay, France). pp 301-45 of Cargese Lectures in Physics. Volume 1. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

The previous measurement of the interaction $e + p \rightarrow e' + n + \pi^+$ leading to the determination of F_π is considered. Hand's experiments are taken into special consideration. (J.F.P.)

7473 SIMPLE MODEL FOR AXIAL MESONS. Leal, Ferreira J.; Zimerman, A. H. (Instituto de Fisica Teorica, Sao Paulo, Brazil). Nuovo Cim. (10), 52A: 957-60(Dec. 1, 1967).

A previously considered model, in which axial currents are the sources of axial mesons just as vector currents are sources of vector mesons, is discussed. The interactions $\pi + N$ and $\gamma + N \rightarrow \pi + N$ are considered. (J.F.P.)

7474 ELECTROMAGNETIC FORM FACTOR OF THE PION. Block, M. M. (Northwestern Univ., Evanston, Ill.). Phys. Lett., 25B: 604-7(Nov. 27, 1967).

The divergence problem in a previous formalism developed by Schiff in order to allow calculation of the distortion of the nuclear phase shifts due to the presence of the Coulomb field, in order to deduce the meson (π) form factor from the elastic scattering of charged mesons (π) on nuclear targets with zero isospin, is resolved. Experiments previously carried out in the energy region 85 and 148 MeV/c, using helium-4 as the target nucleus are analyzed. (J.F.P.)

7475 INVERSE MASS APPROXIMATION TO THE SATURATION OF THE ALGEBRA OF VECTOR DENSITIES. Barnes, K. J. (Imperial Coll. of Science and Tech., London). Nuovo Cim. (10), 52A: 903-11(Dec. 1, 1967).

A new approximation to the saturation of the algebra of vector densities with low-lying states is proposed in which the neglected contributions are proportional to the inverse masses of the resonances concerned. The technique is applied with surprising success to the nucleon electromagnetic form factors in the lowest possible approximation. (auth)

Weak

Refer also to abstract 7502.

7476 (ISS-67/29) RADIATIVE CORRECTIONS TO VECTOR β-DECAYS. Maiani, L. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Sept. 12, 1967. 14p. Dep.

Recent developments in the field of radiative corrections to β-decays are reviewed. These include the attempts to make the corrections finite through a suitable modification of the quark current algebra, as well as the consequences of the existence of the intermediate boson. (auth)

7477 (OULNS-67-7) P-WAVE DECAYS OF HYPERONS AND AXIAL VECTOR MESONS. Ozaki, Kazuhiko; Hosoda, Masataka (Osaka Univ. (Japan). Lab. of Nuclear Studies). [nd]. 5p. Dep.

It is pointed out that P-wave decays of hyperons are also treated by meson-dominance models. The introduction of axial-vector mesons with the decuplet and octuplet and the interaction is used. Then the amplitudes for the hyperon decays can be obtained from the meson-dominance model. Also P-wave amplitudes are calculated within the framework of current algebra using a fundamental identity relation. The prediction of the meson-dominance-model coincides exactly with that of current algebra when certain relations are satisfied. (J.F.P.)

7478 (OULNS-67-9) UNSUBTRACTED DISPERSION RELATIONS IN WEAK INTERACTIONS AND COMPOSITE PARTICLES. Kanki, Takeshi; Saito, Takesi (Osaka Univ. (Japan). Lab. of Nuclear Studies). [1967]. 15p. Dep.

The $\pi \rightarrow \mu + \nu$ and baryon + antibaryon $\rightarrow \mu + \nu$ processes are investigated under the condition that a pion is a Regge particle. A somewhat simplified model is used, i.e., baryons have degenerate mass and only the baryon-antibaryon states are taken into account for the unitarity. It is found that the unsubtracted dispersion relation does not hold for the invariant amplitude of $\pi \rightarrow \mu + \nu$ decay, and the eigenvalue restriction on the strong-interaction parameters, suggested by Nishijima, does not come out. These results are the immediate consequence of the Regge pion. The following properties of the Regge pion play the crucial role: The composite pion can couple only one eigenchannel but not many eigenchannels, and the improper vertex function with the pion off the mass shell (form factor) has a certain high-energy behavior. The amplitude of the baryon-antibaryon process can

satisfy the unsubtracted dispersion relation even for the Regge pion. The partially conserved axial vector current hypothesis is established if and only if the weak decay can occur through only the eigenchannel to which the pion be coupled. (auth)

7479 TCP INVARIANCE AND $K \rightarrow 2\pi$ DECAYS. Strocchi, F. (Istituto Nazionale di Fisica Nucleare, Pisa, Italy. Scuola Normale Superiore, Pisa, Italy). Phys. Rev. Lett., 19: 1456-8 (Dec. 18, 1967).

The discrepancy between the π-π phase shifts as deduced from analysis of $K \rightarrow 2\pi$ decays and the value obtained from strong interaction experiments is examined. A possible explanation given is that the $K \rightarrow 2\pi$ decays are TCP nonconserving. The implications of CP and time-reversal invariance are also discussed. (L.B.S.)

7480 DETERMINATION OF THE $\Delta S/\Delta Q = -1$ AMPLITUDE IN THE SEMILEPTONIC DECAYS OF NEUTRAL K MESONS. Olesen, P. (Univ. of Rochester, N. Y.). Phys. Rev. Lett., 19: 1451-3(Dec. 18, 1967).

The ratio $x = T(\Delta S/\Delta Q = -1)/T(\Delta S/\Delta Q = 1)$ is determined from recent charge-asymmetry data in the processes $K_L^0 \rightarrow \pi^+ + e^+ + \nu$ and $K_L^0 \rightarrow \pi^+ + \mu^+ + \nu$. Rex = 0.14 ± 0.06 and Rex = −0.16 ± 0.24, respectively. (auth)

7481 WEAK INTERACTIONS. Nagy, Tibor (Lorant Eotvos Univ., Hungary). Fiz. Szemle, 17: 257-71(Sept. 1967). (In Hungarian).

A study of decay and collision processes of microparticles reveals that some of these events occur at a high intensity while others take place very rarely. In matters of unit density, the mean free path of nucleons is of the order of 10 cm while neutrinos may travel 10^{17} km without interacting. The time of life of the recently discovered resonance particles is of the order of 10^{-22} to 10^{-23} seconds; mesons and hyperons decay after "only" 10^{-8} to 10^{-10} seconds after generation. Weak interactions play an important role in the study of microparticles; recent achievements in the field of hadron physics helped to clarify their structure to a great extent. These problems are reviewed in detail, starting with the β decay, then examining in turn the problems related to processes involving the neutrino, antineutrino, muon decay and capture, nonconservation of parity, leptonic and nonleptonic decay of hadrons, and CP invariance. It is emphasized that the various elementary processes may be understood only if these interactions are brought together to form a unitary picture. (Review article) (TTT)

7482 PHENOMENOLOGY AND EXPERIMENTAL INFORMATION ON THE $K-\bar{K}$ SYSTEM. Steinberger, J. (CERN, Geneva. Columbia Univ., New York). pp 3-27 of Cargese Lectures in Physics. Volume 1. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

The discussion of $K-\bar{K}$ phenomenology includes the decay matrix, unitarity, $K_L \rightarrow \pi^+ + \pi^-$, CP violation in $K \rightarrow 3\pi$ decay, $K \rightarrow \pi + \mu$ and $K \rightarrow \pi + e + \nu$, and the phenomenology of $K^0 \rightarrow 2\pi$ decay. Also covered are the prediction of various models for ϵ, $\eta\pm$, and $\eta 00$, and experiments to study $\eta\pm$. (J.F.P.)

7483 NON-LEPTONIC WEAK INTERACTIONS. Bludman, S. A. (Univ. of Pennsylvania, Philadelphia). pp 203-55 of Cargese Lectures in Physics. Volume 1. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

The discussion of nonleptonic weak interactions covers weak interaction phenomenology, CP invariance and SU(3) symmetry, soft pion emission and meson (K) decays, and nonleptonic hyperon decays. (J.F.P.)

7484 PRODUCTION CROSS SECTION FOR HYPERONS IN ANTINEUTRINO BEAMS. Parshikura, S. N.; Folomeshkin, V. N. Yadern. Fiz., 6: 654-5(Sept. 1967). (In Russian).

The production of hyperons by the reactions $\bar{\nu}p \rightarrow \mu^+\Lambda^0(\Sigma^0)$ and $\nu n \rightarrow \mu^+\Sigma^-$ is important in confirming the rule $\Delta Q = \Delta S$ and in confirming the relations between the form factors of a baryon octet, which follow from SU(3)-symmetry. Since experimental form factors of the proton and neutron were known with a high degree of accuracy over a wide range of momenta, these experimental values were used in calculating the cross sections for hyperon production. The agreement between the experimental and calculated values is good. The ratio of the cross sections of hyperon production and of elastic scattering at energies of 5 to 20 GeV is equal to $\sigma(\Lambda)/\sigma(N) \approx 1/20$ and $\sigma(\Sigma^-)/\sigma(N) \approx 1/37$. (TTT)

7485 S-WAVE NONLEPTONIC HYPERON DECAYS AND MODELS OF BARYONS. Nakagawa, M.; Trofimenkoff, N. N. (Australian National Univ., Canberra). Nuovo Cim. (10), 52A: 961-4(Dec. 1, 1967).

Further aspects of a theory of S-wave nonleptonic hyperon decays, based on a nonrelativistic quark model of baryons in which the S-wave decays are due to the emission of the meson (π) by a single quark, are discussed specifically with the aim of saving the $\Delta I = 1/2$ rule when the usual CP-invariant current × current, V − A Hamiltonian is assumed as the primary weak interaction. The theory is also extended to the three-triplet and quartet models of baryons. (J.F.P.)

7486 CURRENT ALGEBRA AND VECTOR FORM FACTOR OF $K_{\ell 4}$. Monhanti, A. K.; Marshak, R. E. (Univ. of Rochester, N. Y.). Nuovo Cim. (10), 52A: 965-8(Dec. 1, 1967).

The vector form factor of $K_{\ell 4}$ is calculated according to a procedure applied to $\eta \rightarrow 2\pi\gamma$ decay. Although its effect on the decay rate was found to be small, it has an appreciable effect on the left − right asymmetry where it interferes with the axial vector form factor. Also the results are compared with those of the vector-dominance method. (J.F.P.)

7487 HYPERON NONLEPTONIC DECAY. Itzykson, C. (CEN de Saclay, Gif-sur-Yvette, France). J. Phys. (Paris), 28: 845-56(Oct. 1967). (In French).

The applications of current algebra to nonleptonic hyperon decay are reviewed. The theoretical predictions are then compared with the most recent experimental data. (auth)

Strong (General)

Refer also to abstract 7637.

7488 (JINR-P2-3562) O SPETSIFIKE KASKADNYKH RASCHETOV NEKOTORYKH PROTSESSOV. (On Specific Character of Cascade Calculations of Some Processes). Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 6p. (In Russian). Dep.

The problem of increasing the counting efficiency for some processes of fast particle interactions with the nucleus is considered. A specific technique is suggested for calculation of double charge-exchange of mesons on nuclei, strange particle production and for calculation of superhigh-energy collisions. (auth)

7489 (UCSD-10-P-10-29) REGGE POLE THEORY. Frazer, William R. (California Univ., La Jolla, San Diego). July 1967. Contract AT(11-1)-Gen-10. 47p. Dep. CFSTI.

The discussion of Regge pole theory includes meson (π) − nucleon scattering, the Sommerfeld − Watson transformation, uniqueness of the Sommerfeld − Watson transformation, the Froissart − Gribov continuation and signature, the connection with bound states and resonances, Regge trajectories, analytic properties of Regge trajectories and residues, and factorization of residues. Also considered are the kinematics of crossing, crossing relations for helicity amplitudes, parity-conserving helicity amplitudes and kinematical singularities, Regge poles for Re $J < -1/2$, and Regge poles in forward $\pi + N$ scattering. (J.F.P.)

7490 CLOSURE, LOCALITY, AND THE BOOTSTRAP. Chew, Geoffrey F. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev. Lett., 19: 1492-5(Dec. 25, 1967). (UCRL-17940).

It is argued that the pure bootstrap idea may be physically incompatible with the closure property of conventional quantum theory; a physical meaning for locality would then be precluded in a bootstrap regime. (auth)

7491 VALIDITY DOMAINS OF THE ONE-PION EXCHANGE THEORY. Yock, P. C. M. (Univ. of Auckland, Australia). Nuovo Cim. (10), 52A: 952-6(Dec. 1, 1967).

It is pointed out that the agreement of the one-pion-exchange theory with experimental data may be regarded as a consequence of both the strength as well as the range of the pion-exchange force. The two-body scattering process $a + b \rightarrow c + d$, in which the particles are spinless and have equal mass, is considered. It is noted that the analysis used allows for maximum constructive interference in the low partial waves. This argument may be reversed to yield upper limits for coupling strengths. The method is illustrated by considering the example $\pi^+ + \pi^+ \rightarrow p^+ + p^+$. (J.F.P.)

Strong (Baryon No. = 0)

Refer also to abstract 7479.

7492 (INFN/AE-66/6, pp 46-101) APPLICAZIONE DEL METODO DEI MINIMI QUADRATI A PROBLEMI TIPICI DELLA FISICA DELLE PARTICELLE. (Application of the Method of Least Squares to Typical Problems in Particle Physics). Schiavon, P. (Istituto Nazionale di Fisica Nucleare, Trieste (Italy)). (In Italian).

The theoretical basis of the method of least squares is outlined

and a digital computer program in FORTRAN IV for the numerical evaluation is given. The applicability of the method of least squares is illustrated by analysis of the experimental data from the measurement of the ratio of the decay frequency $\rho^- \to \pi^- + \gamma$ and $\rho^- \to \pi^- + \pi^0$. The problems with the geometric and kinematic fit necessary for the classification of the events in the analysis of the decays are considered. (J.S.R.)

7493 LOW-ENERGY PION–PION PHASE SHIFTS. Fulco, Jose R. (Univ. of California, Santa Barbara); Wong, David Y. Phys. Rev. Lett., 19: 1399-1402(Dec. 11, 1967).

It is shown that the most satisfactory pion–pion phase shift solution consistent with the forward dispersion relation, forward-backward asymmetry in $\pi^-\pi^0$, and some results of earlier studies is a solution corresponding to an I = 0 scattering length of $\sim 0.8\lambda_\pi$, as compared to Weinberg's value of $\sim 0.2\lambda_\pi$. The energy dependence of the amplitudes is determined from the dispersion relations and the unitarity condition without parametrizing the amplitudes. (L.B.S.)

7494 REGGE-POLE MODELS FOR PION EXCHANGE REACTIONS. Durand III, Loyal (Univ. of Wisconsin, Madison). Phys. Rev. Lett., 19: 1345-8(Dec. 4, 1967).

The problem of obtaining a satisfactory Regge-pole model for the pion-exchange reactions $np \to pn$, $\pi N \to \rho N^*$, $\gamma p \to \pi^+ n$, and $\bar{p}p \to \bar{N}^* N^*$, is discussed with particular emphasis on the dynamics as seen in the s channel. It is pointed out that (i) satisfactory models can be obtained using a modified conspiracy model; (ii) pion exchange should provide the dominant contribution to the forward cross sections for incident momenta up to 30 to 50 GeV/c; and (iii) the energy dependence of the differential cross sections should change from that characteristic of pion exchange for $t \sim 0$ to that characteristic of the exchange of vector or tensor mesons at large momentum transfers $t \lesssim -0.5$ $(GeV/c)^2$. (auth)

7495 AXIAL MESONS, CURRENT ALGEBRA AND SUPERCONVERGENT RELATIONS. Savoy, C. A.; Zimerman, A. H. (Instituto de Fisica Teorica, Sao Paulo, Brazil). Nuovo Cim. (10), 52A: 969-71(Dec. 1, 1967).

The d-wave coupling constant is studied, and its effect on the $A_1 \to \rho + \pi$ is determined. The calculation is based on a superconvergence relation which is conjectured from the assumption of the validity of SU(2) × SU(2) chiral symmetry in the limit of infinite momentum transfer. (J.F.P.)

7496 ON A MODEL FOR SATURATION OF A SUPERCONVERGENT SUM RULE. Narayan, D. S. (International Atomic Energy Agency, Trieste, Italy). Nuovo Cim. (10:), 52A: 712-18(Dec. 1, 1967).

A superconvergent sum rule, regarded as an identity valid for all values of the momentum transfer t in the neighbourhood of t = 0, implies such conditions which are quite unlikely to be satisfied by saturating the sum rule by a finite number of resonances. Even though this may imply that there is an infinite number of resonances saturating the sum rule, the contributions from higher resonances to an amplitude are known to decrease rapidly so that they make up only a sort of background over a finite number of low-lying resonances. A model of achieving this using Regge pole theory without introducing a large number of higher resonances is presented. (auth)

7497 THEOREM OF UNIQUENESS. Bessis, D.; Martin, A. (CERN, Geneva). Nuovo Cim. (10), 52A: 719-26(Dec. 1, 1967).

It is shown in the framework of axiomatic field theory, that, for the $\pi^0\pi^0$ elastic scattering, the knowledge of the modulus of the amplitude in the physical region fixes the amplitude entirely. (auth)

7498 AXIAL VECTOR RENORMALIZATION AND THE GOLDBERGER–TREIMAN RELATION. Stern, H.; Brout, R. (Univ. Libre, Brussels) Nuovo Cim. (10), 52A: 727-35(Dec. 1, 1967).

The Nambu and Gell-Mann–Lévy versions of the Goldberger-Treiman relation are compared by going to the chiral conservation limit and then passing to the physical problem of partial chiral conservation. Using current algebra it is shown that the Adler-Weisberger sum rule is rigorously correct in the chiral limit for both cases. In the Nambu case F_A is renormalized in the chiral limit. Going to the physical situation then further increases F_A in Nambu's case to about 1.5, but simply gives back the A-W value of about 1.2 in the Gell-Mann–Lévy case. On this basis, present theory favors the Gell-Mann–Lévy over the Nambu interpretation. (auth)

7499 SUPERCONVERGENCE SUM RULES FOR BARYON–ANTIBARYON SCATTERING. Gupta, V.; Narayan, D. S. (International Atomic Energy Agency, Trieste, Italy). Nuovo Cim. (10), 52A: 736-45(Dec. 1, 1967).

Superconvergence sum rules for baryon-antibaryon scattering amplitudes are derived assuming that the Regge pole theory describes their high-energy behavior. Superconvergence sum rules are obtained in both the forward and backward direction. Explicit expressions for the sum rules for equal-mass baryon-antibaryon scattering are given assuming that they can be saturated by meson poles of zero width. (auth)

7500 EXTENSION OF THE AXIOMATIC ANALYTICITY DOMAIN: KAON–KAON AND PION–KAON SCATTERING. Sommer, G. (CERN, Geneva). Nuovo Cim. (10), 52A: 850-65 (Dec. 1, 1967).

Some extended domains of validity of dispersion relations for the reactions $K + K \to K + K$, $K + \bar{K} \to K + \bar{K}$, $K + \bar{K} \to \bar{K} + K$, $\pi + K \to \pi + K$, $\pi + K \to K + \pi$, $K + \bar{K} \to \pi + \pi$ are collected. The results are shown. (auth)

7501 SOME ANALYTICITY PROPERTIES OF THE TWO-BODY SCATTERING AMPLITUDE. Martin, Andre (CERN, Geneva). pp 347-400 of Cargese Lectures in Physics. Volume 1. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

Recent progress in the derivation of the analytic properties of the scattering amplitude from axiomatic field theory and the application of these results are discussed. The methods of axiomatic field theory are not used, but beginning with the standard results of this theory an attempt is made to proceed further using the additional requirement of unitarity. The case of $\pi + \pi$ scattering is considered. (J.F.P.)

Strong (Baryon No. = 1)

Refer also to abstracts 7494, 7524, and 7525.

7502 (JINR-P2-3555) ASIMPTOTICHESKAYA SU(3)-SIMMETRIYA, UGLY KABIBBO I PRAVILA SUMM DLYA KONSTANT SVYAZI PSEVDOSKALYARNYKH MEZONOV S BARIONAMI. (Asymptotic SU(3) Symmetry, Cabibbo Angles, and Sum Rules for the Constants of Pseudoscalar Mesons With Baryons). Gerasimov, S. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 6p. (In Russian). Dep.

The dispersion sum rules for the form factors of the weak baryon current are considered under the assumption of the asymptotic validity of SU(3) symmetry at large momentum transfers and when the effect of the nearest poles in t-channel is predominant. The relations between the coupling constants of pseudoscalar mesons with baryons are discussed. (auth)

7503 (LPTHE-TH-217) SUPERCONVERGENCE AND BOOTSTRAP IN STATIC MODELS. Diu, B. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Sept. 1967. 40p. Dep.

A comparison between saturated superconvergence sum rules and bootstrap relations is carried out in static models. After a discussion on the possible meaning of superconvergence in such models, the analogy found in the πN case is shown to hold in more general situations. A number of important differences are however brought out by a more detailed investigation. In particular, the validity of the saturation approximation is seriously questioned: whether the relations it gives are satisfied seems to be independent, in these static models, of the convergence of the amplitudes. (auth)

7504 (NP-17150) CURRENT-ALGEBRA CALCULATION OF THE Λ TO Σ RATIO IN THE ISOSPIN-1 S-WAVE $\bar{K}N$ REACTION Iwao, Syurei (Tokyo Univ. of Education (Japan). Dept. of Physics). [1966]. 4p. (TUEP-67-17).

The ratio of the Λ to Σ in the isospin 1 state for the S-wave $\bar{K}^0 + p$ interaction and the relevant parameters are estimated on the basis of current algebra assuming the partially conserved axial-vector current, the soft pseudoscalar meson hypothesis, and SU(3) symmetry. It is found that the current algebra calculation explains at least quantitatively the absorptive part of the S-wave $\bar{K}N$ reaction, however, the large discrepancy between the theoretical value and the experimental one for $\bar{K}^0 + p$ ($K^- + p$) remains to be explained. (J.F.P.)

7505 (UCRL-17903) SPIN DEPENDENT EFFECTS IN πN AND NN INTERACTIONS. Steiner, Herbert (California Univ., Berkeley. Lawrence Radiation Lab.). Oct. 1967. Contract W-7405-eng-48. 50p. Dep. CFSTI.

Some of the experimental and theoretical considerations that are pertinent to the study of spin-dependent effects in πN and NN

interactions are discussed. The basic formalism is outlined, and the experimental situation in πN scattering at energies where resonance production is important is discussed. Also the experimental situation at high energies is considered with emphasis on the crucial tests of high energy theories afforded by the study of various spin-dependent quantities in πN and NN scattering. (J.F.P.)

7506 (UCRL-17921) PHASE CONTOURS OF SCATTERING AMPLITUDES. Chiu, Charles B.; Eden, Richard J.; Tan, Chung-I (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 7, 1967. Contract W-7405-eng-48. 19p. (CONF-680103-1). Dep. CFSTI.

From Conference on High-Energy Collisions of Hadrons, Geneva, Switzerland.

The method of phase contours and its application to some problems in the study of strong interactions is described. A brief discussion is given for the properties of phase contours, phase contours for meson (π)–nucleon scattering, phase contours in a Regge pole model for meson (π)–nucleon scattering, resonance poles and zeros in a crossing symmetric model, and fixed-angle scattering at high energies. (J.F.P.)

7507 APPLICATION OF THE PARTITIONING TECHNIQUE TO SCATTERING PROBLEMS IN THE THEORY OF NONRELATIVISTIC FERMION–BOSON QUANTUM FIELDS. Redei, L. B. (Umea Univ., Sweden). Int. J. Quant. Chem., 1: 799-808(Nov. 1967).

The partitioning technique is used to calculate the approximate scattering amplitude for elastic fermion-boson scattering in nonrelativistic quantum field theory. The approximation is not based on a power series expansion in the coupling constant and it is therefore applicable even in the case of strong coupling. For the applicability of the proposed approximation scheme it is required that the coupling should be linear in the boson field and that virtual fermion-antifermion pair creation processes can be neglected. As an example low energy pion-nucleon scattering is discussed in detail. (auth)

7508 BACKWARD πN CHARGE-EXCHANGE SCATTERING AND POLE EXTRAPOLATIONS OF BARYON REGGE-EXCHANGE AMPLITUDES. Barger, V.; Cline, D. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev. Lett., 19: 1504-7(Dec. 25, 1967). (COO-881-126).

High-energy $\pi^{\pm}p$ backward elastic-scattering data are analyzed in terms of N_{α} and Δ_{δ} Regge exchanges. Using the signs of the Regge residues found from extrapolations to the particle poles (which agree with the signs obtained from interference with direct-channel resonances), the $\pi^-p \to \pi^0n$ cross section near 180° is predicted. (auth)

7509 BOOTSTRAPLIKE CONDITIONS FROM SUPERCONVERGENCE. Ademollo, M. (Harvard Univ., Cambridge, Mass.); Rubinstein, H. R.; Veneziano, G.; Virasoro, M. A. Contract Nonr-1866(55). Phys. Rev. Lett., 19: 1402-5(Dec. 11, 1967).

The generalized superconvergent sum rules are studied for a number of processes of the kind $P + P \to P + V$, where P and V stand for pseudoscalar and vector mesons, respectively. Simple algebraic equations are found for the parameters of the leading Regge trajectories which are exchanged. The results are in good agreement with experiments. The limit of SU(3) symmetry is also considered. (auth)

7510 RISING TRAJECTORIES, FALLING RESIDUES, AND EXPERIMENT. Goldberg, H. (Northeastern Univ., Boston). Phys. Rev. Lett., 19: 1391-2(Dec. 11, 1967).

A limited experimental test is made of a recent speculation that the Regge residue function, $\beta(s)$, shows an exponential or faster decrease with $\alpha(s)$ as $s \to \infty$ to ensure polynomial boundedness for the total amplitude. (auth)

7511 $\pi^-p \to \rho^-p$ IN THE ABSORPTION MODEL. Siddique, M. H. (Inst. of Theoretical Physics, Geneva). Helv. Phys. Acta, 40: 907-14(Nov. 15, 1967).

The absorption model is applied to study the reaction $\pi^-p \to \rho^-p$ at 4 GeV/c, the reaction being assumed to take place only through pion-exchange. The absorption factor was taken to be a function of orbital angular momentum only and an exact partial wave summation was made instead of using an approximate integral expression. The result shows that at small angles the pion-exchange is the dominating factor, but at large angles the contribution from a possible vector-exchange may be important. It is also found that the unitarity limit for partial waves is not violated in contrast to the simple one-meson exchange model where this limit is definitely violated for at least a few low partial waves. (auth)

7512 SUM RULES FOR MULTIPION PRODUCTION PROCESSES. Satz, H. (Univ. of California, Los Angeles). Phys. Rev. Lett., 19: 1453-5(Dec. 18, 1967).

An additive quark model (together with an isospin distribution of charge configurations) is used to establish sum rules connecting pion-nucleon with nucleon-nucleon induced multipion production cross sections. The resulting relations are shown to be well satisfied by present experimental data. (auth)

7513 HIGH-ENERGY BEHAVIOR OF π–N SCATTERING AND THE REGGE POLE MODEL. Gajdicar, T. J.; Moffat, J. W. (Univ. of Toronto). Phys. Lett., 25B: 608-11(Nov. 27, 1967).

The $\alpha_{\pm} = \mathrm{Re}f_{\pm}/\mathrm{Im}f_{\pm}$ are calculated by linear, quadratic and cubic least squares fits to the recent Coulomb interference data and used to analyze high-energy π–N scattering. It is found that the results are consistent within the systematic error with a cross-over in $\sigma^{(-)}(\nu)$ above 22 GeV. It is also found that there is a discrepancy at $\approx$ 18-20 GeV between the charge exchange cross sections and $\mathrm{Re}f^{(-)}$ obtained from the previous data. (auth)

7514 SCATTERING OF HIGH-ENERGY HADRONS WITH A LARGE MOMENTUM TRANSFER. Azimov, S. A.; Arushanov, G. G.; Rasulkulov, M. S. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk. Uzb. SSR.; No. 6, 19-21(1967).

The integral Bessel functions for scattering amplitudes at small momentum transfer are used for developing formulas for high-energy hadron scattering with large momentum transfer. The obtained formulas were compared with the experimental data on π^-p^- scattering at 8 GeV. (R.V.J.)

7515 DIPS IN THE ω-EXCHANGE CONTRIBUTION TO $\pi N \to \rho N$. Contogouris, A. P.; Van, J. Tran Thanh; Lubatti, H. J. (Faculte des Sciences, Orsay, France). Phys. Rev. Lett., 19: 1352-5(Dec. 4, 1967).

A specific combination of the differential cross sections for $\pi^+p \to \rho^+p(d\sigma_+/dt)$ and $\pi^-p \to \rho^0n(d\sigma_0/dt)$ is considered which, at high energy, isolates the contribution of the ω Regge trajectory. Usual Reggeization rules and Mandelstam analyticity requirements predict that this combination should exhibit pronounced dips at $t \simeq -0.5$ (GeV/c)^2 and $t \simeq 0$. Analysis of the existing data at pion incident laboratory momentum $p_0 = 4$ and 8 GeV/c is found to support these predictions. (L.B.S.)

7516 PARTIAL-WAVE ANALYSIS OF THE REACTION π-p $\to \eta$n IN TERMS OF THE HOMOGENEOUS LORENTZ GROUP. Nath, L. M. (International Center for Theoretical Physics, Trieste, Italy). Nuovo Cim. (10), 42A: 52A: 944-7(Dec. 1, 1967).

In the analysis of the reaction $\pi^- + p \to \eta + n$ in terms of the homogeneous Lorentz group there is associated with A_2 another quantum number corresponding to the eigenfunction of the Casimir operator j_0 of the group 0(3,1). Comparing the theoretical expectations from this analysis with experimental results, it was found that the A_2 Regge trajectory is a combination of two trajectories with $j_0 = 0$ and $j_0 = 1$, respectively. One of the predictions of this analysis is that there exists a minimum in the differential cross section near $t = -1$ (GeV)^2. (J.F.P.)

7517 SUM-RULE ANALYSIS OF KAON–NUCLEON SCATTERING. Razmi, M. S. K.; Ueda, Y. (Univ. of Toronto). Nuovo Cim. (10), 52A: 948-51(Dec. 1, 1967).

Sum rules for $K^+ + p$, $K^- + p$, $K^+ + n$, and $K^- + n$ interactions are considered. It is found that the values of the Regge parameters determined from the high-energy data satisfy within the experimental accuracy the sum rules which connect them to the low-energy data. This may be regarded as checking the overall consistency. (J.F.P.)

7518 NONLEPTONIC TWO-PION DECAY OF THE Ω^--PARTICLE. Cwiok, S. (Univ. of Warsaw). Nuovo Cim. (10), 52A: 924-30(Dec. 1, 1967).

The nonleptonic two-pion decay $\Omega^- \to \Xi^- + 2\pi^0$ is considered. Calculations show that the probability of this decay mode is comparable with that of $\Omega^- \to \Xi + \pi$. Hence it follows that in the search of the Ω^- it is necessary to consider also the nonleptonic two-pion decay modes of this particle. It is assumed that the nonleptonic two-pion decay mode of the Ω^- particle goes via the intermediate state Ξ^* (1529). The width, lifetime, and branching ratio are found. (J.F.P.)

7519 REGGE-POLE PREDICTION FOR $\pi^+ + p \to \eta + \Delta^{++}$ (1238). Krammer, M. (CERN, Geneva). Nuovo Cim. (10), 52A: 931-4(Dec. 1, 1967).

The cross section and the Δ^{++} spin–density matrix elements of the interaction $\pi^+ + p \to \eta + \Delta^{++}$ (1236) are predicted. The prediction is based on a $\rho + A_2$ Regge pole analysis of the process $K^+ + p \to K^0 + \Delta^{++}$ (1236) and the SU(3) relation $\gamma_{\pi^+\eta A_2} = \sqrt{2/3}\,\gamma_{K^+K^0A_2}$. Also the total cross section for the interaction studied is evaluated and shown as a function of the π^+ laboratory mo-

mentum. The rather flat t-dependence of the differential cross section for the studied reaction is in sharp contrast to the other two-body reactions in $\pi^+ + p$ scattering. The assumption that the dominant A_2 exchange amplitudes do not vanish at $\alpha_{A_2} = 0$ is the main reason for the good agreement of the model predictions with the experimental data. (J.F.P.)

7520 SIMULTANEOUS s–t ANALYTICITY FOR INELASTIC TWO-BODY REACTIONS FROM AXIOMATIC FIELD THEORY. Sommer, G. (CERN, Geneva). Nuovo Cim. (10), 52A: 966-78(Dec. 1, 1967).

It is proved for inelastic two-body reactions $A + B \rightarrow C + D$, that the amplitude, if fulfilling an ordinary fixed negative t dispersion relation, is simultaneously analytic in s and t in a topological product of the form

$$P_D = \left\{ s,t \middle| \begin{array}{l} s \in \text{cut plane} \\ t \in D \text{ (independent of s)} \end{array} \right\}.$$

As an example, the method is applied to the $\pi + \Lambda \rightarrow \pi + \Sigma$ amplitude which is shown to have a dispersion relation in a complex domain $D_{\pi\Lambda \rightarrow \pi\Sigma}$. (auth)

7521 Ω^- AS A $\Xi\bar{K}$ BOUND STATE. Johnson, W. R. (Univ. Notre Dame, Ind.); Kahane, J. Nuovo Cim. (10), 52A: 746-71 (Dec. 1, 1967).

The dynamical existence of the Ω^--particle (1675 MeV) as a $\frac{3}{2}^+$ bound state of the $\Xi\bar{K}$ system was re-investigated. The standard one-channel N/D formalism is used and the input forces are approximated by the Born amplitudes for all low-lying one-particle (or resonance) exchange diagrams up to and including the Y_1^* (1385 MeV) exchange. The amplitude for the Y_1^* exchange when computed as though the Y_1^* were a stable particle leads to an obviously incorrect high-energy behavior and necessitates the introduction of a damping factor into this amplitude. The Regge pole description of the Y_1^* introduces, in a natural way, such a damping factor. Using this Regge type damping factor the Ω^- can be produced for reasonable values of the parameters that enter. (auth)

7522 OVERLAP FUNCTION ANALYSIS OF $\pi^\pm p$ ELASTIC AND CHARGE EXCHANGE SCATTERING AT HIGH ENERGIES. Henzi, R. (CERN, Geneva). Nuovo Cim. (10), 52A: 772-99 (Dec. 1, 1967).

In terms of overlap functions, a new kind of analysis of πN elastic and charge exchange scattering data at high energies and small momentum transfers is given. The data analyzed cover a range 6 GeV/c $\lesssim q_L$ = pion laboratory momentum $\lesssim$18 GeV/c and $0 \leq -t$ = (centre-of-mass momentum transfer)$^2 \lesssim 1$ (GeV/c)^2. The phenomenological expressions of the scattering amplitudes, including spin-flip, as they are obtained from experiment, are traced back to simple forms for the $\pi^\pm p$ overlap functions. The latter are interpreted in terms of different classes of inelastic $\pi^\pm p$ collisions, each contributing with a characteristic power of s = (centre-of-mass energy)^2 to the overlap functions. The dominant deviations from the genuine asymptotic situation (where $\pi^+ p$ and $\pi^- p$ elastic scattering are expected to be identical) are attributed to the presence of "charge annihilation channels" among $\pi^- p$ inelastic transitions which have no counterpart among the $\pi^+ p$ inelastic transitions. In this context the concepts of absorptive corrections and of a common interaction volume for both elastic and inelastic collisions are encountered within the overlap function framework. The actual simple forms adopted for the overlap functions imply that the charge exchange peak must remain somewhat broader than the elastic ones, so that in the case of constancy of the latter the observed shrinkage of the former is predicted to slow down and stop, or alternatively but less plausibly, elastic peaks have to start to shrink, the change occurring at an energy somewhat higher than the ones here studied and which is estimated to be $q_L \simeq 26$ GeV/c. Another implication of the overlap functions is that the Reggeized ρ-exchange form of the charge exchange amplitude is supplemented by small corrections. As will be shown later, these account in a natural manner for the measured polarization in $\pi^- p \rightarrow \pi^0 n$. Also the $\pi^\pm p \rightarrow \pi^\pm p$ polarizations will be shown to be satisfactorily described in the formalism. (auth)

7523 NEW FORM FOR DISPERSION SUM RULES. Khalfin, L. S. (Inst. of Mathematics, Leningrad). Yadern. Fiz., 6: 651-4(Sept. 1967). (In Russian).

The source of all dispersion sum rules is a direct result of the theorem of Kosh for the analytical function f(E) which rapidly goes to zero as $E \rightarrow \infty$: $\int_{-\infty}^{\infty} I_m f(E) dE = 0$. The DSR are functionals of the analytical function, which are more stable than the dispersion relations (with respect to experimental errors). A detailed knowledge of the asymptotic of f(E) (for decreasing amplitudes) and knowledge of the asymptotic properties of the correction terms is required to obtain the DSR. These deficiencies of the earlier DSR can be removed by obtaining the DSR from dispersion relations based not on the theorem of Kosh but on the theorem of Keldysh-Sedov. The DSR are listed for decreasing amplitudes of electromagnetic processes and for amplitudes of πN type processes. The use of the new DSR for obtaining relationships between masses, resonance widths and interaction constants is the same as usual, and reduces to calculating integrals of $I_m f(E)$ by means of resonance approximations. (TTT)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 7444, 7494, 7505, and 7512.

7524 (ISS–67/25) EFFECTS OF THE s-STATE PION–NUCLEON INTERACTION ON THE PARTIAL-WAVE NUCLEON–NUCLEON ABSORPTIONS. Francaviglia, S. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Sept. 8, 1967. 14p. Dep.

The absorption in proton–proton scattering around 1 GeV of laboratory kinetic energy of incident proton are computed. A previous calculation is extended by taking into account, besides the production of the resonance I = $\frac{3}{2}$, J = $\frac{3}{2}$(P_{33}), the production of pions in S_{11} and S_{31} state in respect to one nucleon as are inelastic process. These waves are the most important in the hypothesis of P_{33} dominance in scattering. The $^3P_0$ and $^3P_1$ absorptions are found to violate the unitarity limits, while the other waves are almost unaffected. (auth)

7525 (JINR–P2-3561) K VOPROSU O ROZYGRYSHE ELEMENTARNOGO AKTA VZAIMODEISTVIYA PRI RASCHETAKH VNUTRIYADERNOGO KASKADA. (To the Sampling Problem of an Elementary Act of Interaction at the Intranuclear Cascade Calculation). Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 7p. (In Russian). Dep.

A method for sampling the characteristics of inelastic πN- and NN-interactions, when calculating fast particle interaction with the nucleus in terms of cascade theory, is treated. The method suggested exactly takes into account both the conservation of energy principle and the law of momentum conservation. (auth)

7526 (ORNL-TM-1996) PRELIMINARY DATA FROM INTRANUCLEAR-CASCADE CALCULATIONS OF 0.75-, 1-, AND 2-GeV PROTONS ON OXYGEN, ALUMINUM, AND LEAD, AND 1-GeV NEUTRONS ON THE SAME ELEMENTS. Bertini, Hugo W. (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 789p. Dep. CFSTI.

To satisfy the urgent need of researchers for data from high-energy nuclear reactions, a limited amount of data was generated from an intra-nuclear-cascade calculation that is in preliminary form. These data include the total nonelastic cross sections, the cascade and evaporation particle multiplicities, the cascade and evaporation particle energy spectra, the cascade particle angular distributions, the radiochemical cross sections, etc., from 0.75-, 1-, and 2-GeV protons on oxygen, aluminum, and lead, and 1-GeV neutrons on the same elements. It is expected that the data from the final form of the calculation will not differ appreciably from those presented, but this cannot be guaranteed. (auth)

7527 SEPARABLE POTENTIAL FOR THE NUCLEON–NUCLEON INTERACTION. Hammann, Th.; Oberlechner, G.; Trapp, G. (Centre de Recherches Nucleaires, Strasbourg). J. Phys. (Paris), 28: 755-62(Oct. 1967). (In French).

A nonlocal separable potential is presented, which reproduces S, P and D wave phase shifts for nucleon–nucleon scattering up to 350 MeV. This potential contains very strong and short-ranged terms. As a preliminary theoretical test, the binding energy of nuclear matter is calculated using the reaction matrix G of the Brueckner-Goldstone theory. Saturation is found at a density corresponding to a Fermi momentum $k_F = 1.65$ fm^{-1}, with an average binding energy per particle of −18 MeV. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 7660.

7528 (INFN/AE–66/6, pp 117-59) ELEMENTS OF GROUP THEORY. Giorgi, M. (Istituto Nazionale di Fisica Nucleare, Trieste (Italy)).

Lectures are presented on the general concepts of group theory

Lie algebra, roots, and weights, and the symmetric group and its representations. The lectures are intended to serve as an introduction to a review of the unitary symmetry schemes and the quark model of elementary particles. (L.B.S.)

7529 (JINR-E2-3553) POINCARE AND LORENTZ INVARIANT EXPANSIONS OF RELATIVISTIC AMPLITUDES. Sheftel, M. B.; Smorodinskii, Ya. A.; Winternitz, P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 29p. Dep.

A discussion of double expansions of relativistic amplitudes in terms of the irreducible representations of the homogeneous Lorentz group, suggested previously for arbitrary values of the kinematical variables s and t is given. The relation between these expansions and relativistic phase shift analysis in terms of various little groups of the Poincaré group is studied. (auth)

7530 (NP-17138) EXTENSION A SU(3) DE LA METHODE SYMBOLIQUE DE KRAMERS. (Extension of Kramers Symbolic Method to SU(3)). Jasselette, P. (Liege Univ. (Belgium). Faculte des Sciences). 1967. 125p. (In French). Dep.

A calculation method used initially in atomic physics by Kramers is applied to the theory of elementary particles. The method is based essentially on the invariant properties of the system considered for the transformations forming a group. In the original method it is the SU(2) group. For elementary particles it is the SU(3) group, defined with the aid of unitary and unimodular matrices with three dimensions. The theory of unitary symmetry of elementary particles is reviewed and the applicability to the SU(3) group is justified. The original Kramers method for the SU(2) group is presented and its essential constituent elements are given. The elements necessary for the application of the symbolic method are then studied in the SU(3) group. There are two types of difficulties: a much larger number of variables and invariants and the representations in which the method is applicable are reducible. A particular technique of projection of these reducible representations on the irreducible representations is then given. Some numerals called projection coefficients are determined explicitly for all irreducible representations. They permit the precise definition and the utilization of the operator realizing the projection desired. An example is then given of the application of the method. The results obtained are explicit formulas giving the multiplicity of any irreducible representation in the reduction of a direct product of two irreducible representations and an algorithm permitting the calculation of the coupling coefficients or Clebsch-Gordan coefficients corresponding to this product. (tr-auth)

7531 (NP-17151) MODEL OF ELEMENTARY PARTICLES BASED ON INFINITE COMPONENT FIELDS. Iwao, Syurei (Tokyo Univ. of Education (Japan). Dept. of Physics). [1967]. 6p. (TUEP-67-15). Dep.

The model discussed is similar to the SU(9) model in the sense that the basic field contains both integral and half-integral spins. This model also has a spin structure similar to the compact irreducible representation of the SL(2,C) group (in a principle series representation) but the basic group used in the present model is compact. The basic particle transforms as a quark state for the internal space but consists of the set of infinite mechanical spin states differing in one-half unit from zero to infinity. The baryon as well as meson states are considered as bound states of three such particles and particle-antiparticle respectively. The mass spectra expected from this model are briefly discussed. (J.F.P.)

7532 (NP-17185) ELEMENTARY PARTICLES AND UNITARY SYMMETRY. Rodenberg, R.; Cantril, J.; Clark, B. P.; Li, H.; Peery, L.; Tunheim, G.; Yoder, J. (Oklahoma State Univ., Stillwater. Dept. of Physics). Sept. 1966. 201p.

The theory of elementary particles and unitary symmetry is developed in the following topics: relation of T and T_3 to SU(2); charge independence and conservation in strong and electromagnetic interactions; the Noether theorem; T_i for isoscalar, isospinor, and isovector fields; isospin; classification of elementary particles within the isospin formalism; strangeness, Gell-Mann-Nashijima scheme, new particles and Barut Model; strong interaction in SU(2); geometrical interpretation of hypercharge; mass relations (SU(2)); the Sakata model; SU(3) and higher order symmetry groups; structure of simple Lie algebras; Young's tableaux; product representations and generalized Clebsch-Gordan coefficients; magnetic moments of baryons in SU(3); extension to SU(6); and further symmetries. (L.B.S.)

7533 DEGENERATE UNITARY REPRESENTATION OF SU(2,2) GROUP AND ELEMENTARY PARTICLE SYMMETRIES. Ti, Kao (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol., 32: 375-83(1967). (In Russian).

In a preceding work two series of degenerate unitary representations of SU(2,2) group were found. In the present study it is shown that one of these two series (the primary series) belongs to the so-called d_1 series of Graev. Moreover, the possible utilization of the representation of the primary group to the theory of symmetry of elementary particles is indicated. The reduction of $SU(2,2) \supset \{SU(2) \otimes SU(2) \otimes U(1)\}_p$, where p is the 4-momentum of the particle, is given and the classification of the particles with respect to not cited representations of the maximum compact subgroups is reported. The width of the interaction of the infinite multiplet with the field singlet is briefly examined. (tr-auth)

7534 SPACE INVERSION, TIME REVERSAL, AND CHARGE CONJUGATION. Lee, T. D. (Columbia Univ., New York). pp 55-81 of Cargese Lectures in Physics. Volume 1. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

The basic concepts of invariance principles, and their present status are given. The invariance of the electromagnetic interaction under C_{st} and T_{st}, is discussed, and a model is described. (J.F.P.)

7535 ALGEBRA OF CURRENT AND SUM RULES. Gourdin, M. (Univ., Paris). pp 153-201 of Cargese Lectures in Physics. Volume 1. Levy, M. (ed.). New York, Gordon and Breach Science Publishers, Inc., 1967.

Some particular aspects of current algebra are discussed in connection with a dispersion theoretic approach, following essentially the method first explained by Fubini. It is found that the sum rules deduced using the Adler method only do not converge but that the sum rules connected with the amplitude of the expansion probably converge. The Fubini method is found sufficient to deduce all interesting results for A-type sum rules; for S-type sum rules only the Adler method can be used. (J.F.P.)

7536 CURRENT ALGEBRA AND PERTURBATION THEORY. Donini, E.; Sciuto, S. (Univ., Turin). Nuovo Cim. (10), 52A: 839-49(Dec. 1, 1967).

The standard identity of current algebra is proved in a perturbative model at all orders, both for planar and nonplanar diagrams. The proof is carried on following the new approach in the framework of the Khuri representation. (auth)

Applications (Electromagnetic and Weak)

7537 (ITEF-516) ZARYADOVAYA ASIMMETRIYA V RASPADAKH $K^0 \to \pi^+ + \pi^- + \pi^0$. (Charge Asymmetry in $K^0 \to \pi^+ + \pi^- + \pi^0$). Zel'dovich, B. Ya. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki. 1967. 12p. (In Russian). Dep.

The decays of neutral K-mesons into $\pi^+\pi^-\pi^0$ are discussed in connection with the selection rules in isotopic spin T and CP-invariance. The expressions of the isotopic amplitudes of the decay are given taking into account three pions final-state interactions. Special attention is paid to the estimates of the value R of the charge asymmetry. Interference of CP-even amplitudes $K_2 \to (3\pi, T = 1)$ and $K_1 \to (3\pi, T = 2)$ in the K^0 decay close to its production point may result in the value $R \sim 10^{-1} + 10^{-2}$. Charge asymmetry in the K_L-meson decay is proportional to the CP-odd amplitude $K_L \to (3\pi, T = 2)$, its value depends on the isotopic properties of the CP = -1 interaction. A large charge asymmetry (up to 30%) is predicted in the pure $K_S \to \pi^+\pi^-\pi^0$ decay, but the probability of this decay must be very small. (auth)

7538 (JINR-E2-3557) ASYMPTOTIC BEHAVIOR OF THE VERTEX FUNCTION IN THE THEORY OF NONRENORMALIZABLE CP-NONINVARIANT INTERACTION OF PHOTONS WITH SPINOR PARTICLES. Arbuzov, B. A.; Atakishiev, N. M.; Filippov, A. T. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 12p. Dep.

The ladder approximation for the vertex function in a nonrenormalizable CP-violating theory is considered. In the Euclidean domain of the momentum the asymptotics of the exact solution and the exact solution itself (for zero fermion mass) are found. The vertex function in the pseudoeuclidean domain of momenta is obtained by analytic continuation of the exact solution. The function possesses usual analytic properties: it decreases along space-like directions of the momentum and increases along time-like ones. Since the imaginary part of the vertex function on the cut exponentially increases it is impossible to write for it a dispersion relation with finite number of subtractions. (auth)

7539 (SLAC-PUB-349) ELECTROMAGNETIC INTERACTIONS AND SU(3). Harari, Haim (Stanford Linear Accelerator Center, Calif.). Sept. 1967. 17p. (CONF-670725-1). Dep. CFSTI.

From Symposium on the Present Status of SU(3) Symmetry, Argonne, Ill.

The experimental situation with respect to the SU(3) predictions for electromagnetic mass differences, magnetic moments, electromagnetic decays, and photoproduction reactions including pseudoscalar and vector meson production is reviewed. (J.F.P.)

Applications (Strong)

7540 (CONF-670414-6) SYMMETRIC QUARK MODEL OF BARYON RESONANCES. Technical Report No. 686. Greenberg, O. W.; Resnikoff, M. (Maryland Univ., College Park. Dept. of Physics and Astronomy). June 1967. 37p. Dep. CFSTI.

From Meeting of the American Physical Society, Washington, D. C.

The symmetric quark model of baryon resonances is applied to the $(56,0^+)$, $(70,1^-)$, and $(20,1^+)$ supermultiplets. Using a systematic SU(6) analysis and dominance of two-body contributions to the mass operator, the Gürsey–Radicati mass formula for the (56.0^+) is derived without use of perturbation theory. An equal spacing relation is derived for the SU(6)-symmetric mass contribution for the $(56,0^+)$, $(70,1^-)$, and $(20,1^+)$ in ascending order, with the $(20,1^+)$ lying above 2 BeV. A detailed analysis of the $(70,1^-)$, which yields a quantitative fit for the spin-orbit split negative parity resonances, is made with the result that the magnitude of the octet spin-orbit term is about six times greater than the singlet one. The masses and mixing amplitudes for all the resonances in the $(70,1^-)$ are calculated, and it is pointed out that because of the large mixings for $J^P = 1^-/2$ and $3^-/2$, the Gell–Mann–Okubo mass formula cannot be expected to hold for these resonances, so that there is no sense in trying to group them into octets and decuplets. (auth)

7541 (COO-264-403) INFINITE MULTIPLETS. Nambu, Yoichiro (Chicago Univ., Ill.). 1967. 29p. (EFINS-67-80; CONF-670824-3). Dep. CFSTI.

From International Theoretical Physics Conference on Particles and Fields, Rochester, N. Y.

The discussion of infinite multiplets includes the choice of the dynamical group G and its representation, models based on SL(2,C), those based on $SO(4,2) \sim SU(2,2)$, and those based on SU(3,1), and problems of quantized fields. Also scattering processes and application to hadron physics are considered. (J.F.P.)

7542 (ISS-67/36) THE $J^P = 1^+$ OCTODECIMET OF MESON RESONANCES. Gatto, R.; Maiani, L. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Oct. 26, 1967. 15p. Dep.

A discussion is presented of an SU_3 complex (called "octodecimet") arising naturally in the quark picture of boson resonances, and constituted of two mixed nonets with the same spin and parity, and opposite charge conjugation. Mass formulas for the general case are discussed. The possibility that axial vector mesons group into an octodecimet is considered further, and the possible assignments are discussed. Also their decays into vector and pseudoscalar mesons are considered, and experimental data are compared with the predictions of the octodecimet model. Even though very firm conclusions cannot be reached, due to experimental uncertainties, the picture appears to be quite consistent. Some predictions of the model for the production of the mixed strange members of the axial octodecimet are briefly exposed. (auth)

7543 (JINR-P2-3554) SU(3)-SIMMETRIYA I KIRAL'NAYA DINAMIKA PSEVDOSKALYARNYKH MEZONOV. (SU(3) Symmetry and Chiral Dynamics of Pseudoscalar Mesons). Struminskii, B. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 8p. (In Russian). Dep.

A phenomenological Lagrangian for pseudoscalar meson is obtained which is invariant with respect to the chiral group $U(3) \times U(3)$. (auth)

7544 (ORO-2504-112) EXPERIMENTAL TESTS OF SU(3) REACTION PREDICTIONS. Technical Report No. 743. Yodh, G. B. (Maryland Univ., College Park. Dept. of Physics and Astronomy. Arizona Univ., Tucson). Sept. 1967. 29p. Dep. CFSTI.

The present status of experimental tests of reaction predictions of SU(3) is discussed. These have to do with four-point functions and therefore involve dynamics. Attempts to compare pure SU(3) predictions with experiment in some model dependent manner are described, and their significance is discussed. (J.F.P.)

7545 GROUP-CONTRACTION AND IMPACT-PARAMETER REPRESENTATION OF HIGH-ENERGY SCATTERING. Sankaranarayanan, A. (Douglas Advanced Research Labs., Huntington Beach, Calif.). Nuovo Cim. (10), 52A: 935-39 (Dec. 1, 1967).

It is shown that the impact-parameter representation is a realization of breaking spherical symmetry into Euclidean symmetry in two real dimensions. Then it transpires that the impact-parameter representation is a consequence of the contraction of the rotational group O(3) to the Euclidean group I0(2). The elastic scattering of two spinless particles is considered. (J.F.P.)

7546 CLEBSCH-GORDAN COEFFICIENTS FOR SL(n,C). Bamberg, P. G. (Oxford Univ.). Proc. Roy. Soc. (London), Ser. A, 300: 337-55(Sept. 19, 1967).

The Clebsch–Gordan coefficients for the coupling of certain degenerate representations of SL(n,C) are expressed as generalized hypergeometric functions. These coefficient define the baryon "current" which is coupled to the lowest state of a meson tower in the SL(6,C) theory of elementary particles. The asymptotic behavior of the coefficients for high states in the baryon tower is determined. Orthogonality and completeness relations are proved which lead to an explicit formula for decomposing a two-particle state into a direct integral of "currents" which belong to the principal series of meson representations. The relation between SL(n,C) Clebsch–Gordan coefficients and SU(n) 9 – j symbols is explored. (auth)

Field Theories

General

7547 PHYSICAL AND NONPHYSICAL REPRESENTATIONS OF THE GALILEI GROUP. Ryder, L. H. (Oxford Univ.). Nuovo Cim. (10), 52A: 879-91(Dec. 1, 1967).

Even nonrelativistically, spin is not necessarily given by the representations of SU_2. There are "nonphysical" representations of the Galilei group whose little group is noncompact, and hence generates some sort of "infinite" spin. It is shown that these nonphysical representations are the nonrelativistic limit of representations of the Poincaré group for states with spacelike momentum. (auth)

Quantum Field Theory

Refer also to abstract 7465.

7548 (JINR-E2-3583) FAITHFUL REPRESENTATIONS OF ALGEBRAS OF TEST FUNCTIONS. Lassner, G.; Uhlmann, A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 9p. Dep.

It is shown that the topological *-algebra of test functions for Wightman fields can be faithfully represented as an algebra of (unbounded) operators in a separable Hilbert space. (auth)

7549 (JINR-P2-3482) ZAMECHANIE K SPETSIAL'NOI TEORII OTNOSITEL'NOSTI. (One Remark to Special Theory of Relativity). Strel'tsov, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 9p. (In Russian). Dep.

In the framework of the special theory of relativity a different way of describing events is proposed. In this way the events taking place near the observer are classificated by measuring length but not duration. (auth)

7550 THEORY OF FREE RELATIVISTIC MULTIPOLE FIELD. I, CLASSICAL PART. Lukierski, J. (Univ. of Wroclaw). Acta Phys. Pol., 32: 551-77(1967).

The replacement of mass derivative acting on the free Klein-Gordon solution by means of operators which depend on space-time variables is studied. The multipole solution of n-th order is defined as a linear combination of n solutions of the Klein-Gordon equation. There is given a complete discussion of the arbitrariness occurring in this definition. The result that the set ϕ_n of these n solutions forms a n-dimensional triangle representation of the translation group is obtained. The transformations of the set ϕ_n under the Lorentz rotations are also given. The covariance of the Green's functions for different formulations (different choices of ϕ_n) is shown. (auth)

7551 NONLOCAL EFFECTS IN CLASSICAL AND QUANTUM THEORIES. Wisnivesky, D.; Aharonov, Y. (Yeshiva Univ., New York). Ann. Phys. (N. Y.), 45: 479-92(1967).

Quantum effects of electromagnetic potentials are analyzed further. It is shown that other theories, both classical and quantum mechanical, exhibit analogous effects. Examples from classical general relativity, Yang-Mills theory, and quantum field theory are discussed. It is concluded that effects of this kind are not necessarily quantum mechanical in nature and not necessarily related to the appearance of non-gauge-invariant potentials in the formulation of the theory. (auth)

7552 CAUSAL BEHAVIOUR OF NONLOCAL OBJECTS AND PARTICLE STRUCTURE IN FIELD THEORY. Gerlach, Bernd; Gromes, Dieter; Petzold, Joachim; Rosenthal, Peter (Univ., Marburg, Ger.). Z. Phys., 208: 381-9(1968). (In German).

A new expression $\mathfrak{F}^0_4$ for the charge density of the Klein-Gordon field was previously constructed which is positive definite if confined to positive frequency solutions only. This is not the case for the usual charge density. Some properties of $\mathfrak{F}^0_4$ are considered. A generalized definition is proposed, for macrocausality which can be applied to nonlocal expressions too, yielding a causal behavior in the case of $\mathfrak{F}^0_4$. (auth)

7553 DIRAC HAMILTONIAN AS A MEMBER OF A HIERARCHY OF MATRICES. Ramakrishnan, Alladi (MATSCIENCE, Madras). J. Math. Anal. Appl., 20: 9-16(Oct. 1967).

A method of generating a hierarchy of square matrices L_m involving m independent continuous parameters $\lambda_1, \lambda_2, \ldots, \lambda_m$ such that $L^3_m = (\lambda^2_1 + \lambda^2_2 + \ldots + \lambda^2_m)L$, as m takes values 2, 3, ... is given. It is shown that the L matrices can be expressed as a linear combination of m generator matrices independent of the parameters. The L matrices fall into one of two classes, saturated or unsaturated according as m is odd or even. It is pointed out that it is a feature of this hierarchy that the Pauli matrices are recognized to be the generator matrices which saturate L_2, while the Dirac Hamiltonian is an unsaturated L_4. (J.F.P.)

7554 VARIATIONAL FORMULATION OF QUANTUM FIELD THEORY. I. Dahmen, H. D. (Weizmann Inst. of Science, Rehovoth, Israel); Jona-Lasinio, G. Nuovo Cim. (10), 52A: 807-38(Dec. 1, 1967).

A variational approach to quantum field theory is presented which parallels some recent formulations of statistical mechanics. The main interest of this method lies in the fact that the dynamical problem separates naturally into two distinct mathematical problems: (A) One first determines the structure of the skeleton diagrams generated by a given interaction Lagrangian, using certain functional differential equations, which contain propagators or vertex functions as independent variables. These equations permit the direct calculation of the mass operator or of the vertex as functionals of the dressed propagator. Furthermore a simple modification of the vertex equation permits the direct reconstruction of the elementary coupling among given particles if their effective interaction is known. This in turn makes it possible to determine any Green's function as a functional of the propagator and the vertex. (B) The actual space-time-dependence of the dressed propagator and of the vertex function for the particular theory under consideration is then determined by nonlinear equations which can be derived from a variational principle. The formulation is carried through without any reference to perturbation theory and the variational principle contains the usual renormalization constants in the form of undetermined Lagrange multipliers. The mathematical structure of the functional differential equations mentioned under (A) is studied in some detail. Two classes of solutions can in general exist and only one of them can admit the ordinary perturbation series as an asymptotic expansion. It is conjectured that the other class may correspond to a "collapsed" vacuum and that it become relevant in connection with stability problems. Also, the possibility of constructing nonperturbative approximate solutions is explicitly indicated. The nonlinear equation for the propagator mentioned under (B) is tentatively reduced to a form to which implicit function theorems of modern functional analysis can perhaps be applied together with iterative schemes of calculation. However to proceed further a deeper understanding of the renormalization problem is necessary. (auth)

Gravitation and General Relativity

7555 STRESS-TENSOR OPERATOR FOR FERMION FIELD INTERACTING WITH CLASSICAL GRAVITATIONAL FIELD. Kannenberg, L.; Arnowitt, R. (Northeastern Univ., Boston). Ann. Phys. (N. Y.), 45: 416-44(1967).

The interaction between a quantized spin-½ fermion field and a classical gravitational field is studied. The S-matrix elements are expressed in terms of a functional integral of the vacuum expectation value of the fermion stress tensor (and the first quantized fermion Green's functions). The basic problem for such a system is to find an expression for the stress tensor operator that avoids paradoxes analogous to those examined by Schwinger in current commutators. This is solved to first order in the gravitational potentials by "spreading" the points in the usual stress tensor expression and introducing a modified version of the Mandelstam–DeWitt path-dependent functions. The two-sided fermion closed loop (with gravitational vertices) is calculated and is explicitly seen to be conserved, invariant under gravitational gauge transformations, and Lorentz covariant. (auth)

7556 THE FIVE-DIMENSIONAL RELATIVISTIC SCHEME. III. Pyt'ev, Yu. P. Vestn. Mosk. Univ., Ser. III Fiz. Astron., No. 1, 73-81(Jan.-Feb. 1967). (In Russian).

The dynamic variables of the particles in a generalized case of the five-dimensional space R_5 were derived, using the author's previously described coordinate system, in analogy with the plane space. The kinetic equations describing the motion of a particle with a variable rest mass in an external gravitational field were studied. These equations indicated that R_5 is a configurational space with respect to the particle and depends on the ratio of the interaction constants with the field. A similar situation arises when certain assumptions are made in the theroy of gravitation. Nonrelativistic motion was also examined, studying the potential of the external gravitational field, the generalization of the Yukawa potential and elastic and inelastic scattering events on this potential. (TTT)

7557 ENERGY OF A CHARGED PARTICLE IN MOLLER'S TETRAD THEORY. Shah, K. B. (Physical Research Lab., Ahmedabad, India). Proc. Cambridge Phil. Soc., 63: 1157-66 (Oct. 1967).

The energy of the exterior and the interior fields of a particle, charged or otherwise, embedded in an empty space is calculated, using Møller's tetrad formulation of the energy-momentum complex in general relativity. It is found that the exterior field contains positive gravitational energy, and in addition, the electromagnetic energy, if the particle is charged, and that the sum total of the energies of the interior and the exterior fields is equivalent to the Newtonian mass of the particle. (auth)

7558 ON THE INCLUSION OF THE GRAVITATIONAL EFFECT OF THE ELECTROMAGNETIC FIELD IN THE CHARGED MODEL. Sharma, N. K. (Univ. of Rajasthan, Jaipur, India). Nuovo Cim. (10), 52A: 940-3(Dec. 1, 1967).

A report is made of how the inclusion of the gravitational effect of the electromagnetic field influences the working of a previously given model for a stable charged hypersurface in general relativity. Excluding a singularity at Z (the charge multiplicity factor) equals 47, the model is stably charged for all values of Z greater than 47. It is noted that ordinarily Z is very large. It is also pointed out that with the inclusion the gravitational effect of the electromagnetic field the hypersurface ($x^1 = 0$) actually does not remain flat in the region $x^1 < 0$. (J.F.P.)

Scattering Theory

Refer also to abstracts 7412 and 7637.

7559 (CERN-Trans-67-5) TECHNIQUE DES GRAPHES DE REGGE. (Techniques for Regge Trajectories). Gribov, V. N. Translated into French by A. Golovanoff from report ITEF-511. 44p. (In French). Dep. CFSTI. JCL $4.60 fs, $1.52 mf.

The asymptotic contribution of an important class of Feynman diagrams rigorously containing two-body amplitudes is studied. The relation between the asymptotic contribution of these amplitudes and that of the diagrams is found. It is established that the asymptotic contribution of internal amplitudes is determined by a Regge pole, that of the diagrams contains a branch contribution of a previously obtained form. The case in which the pole and branch points are neighbors is examined. It is established that in this case the pole reinforces the branch contribution. The diagram technique applicable to the simultaneous examination of the pole and branches is defined. Finally this diagram technique is used to describe the phenomenon appearing in the diffraction cone of elastic scattering in the Pomeranchuk pole hypothesis. (J.F.P.)

7560 FINITE-RANGE SOLUTIONS TO THE ONE-DIMENSIONAL INVERSE SCATTERING PROBLEM. Portinari, J. C. (Massachusetts Inst. of Tech., Cambridge). Ann. Phys. (N. Y.), 45: 445-51(1967).

Some ideas are suggested concerning the obtention of finite range solutions to the so-called one-dimensional inverse scattering problem. A necessary condition on the ratio of the reflection and transmission coefficients is given for the corresponding potential to be cutoff on both sides. (auth)

7561 SINGULAR SCATTERING EQUATIONS IN MOMENTUM SPACE. Pfaffelhuber, E.; Blomer, R. (Univ., Munich). Ann. Phys. (N. Y.), 45: 404-15(1967).

A new, cutoff-free approach to singular scattering equations in momentum space is developed which applies to four-fermion interactions and singular potentials. Generalized function perturbative solutions are confronted with solutions nonanalytic in the coupling constant. New techniques for dealing with singular interactions in momentum space in terms of analytic continuation procedures are developed which furnish finite, cutoff-free results at each step of approximation. (auth)

7562 INFORMATION CONTENT OF THE BORN SERIES. Schwartz, Charles (Univ. of California, Berkeley). J. Comput. Phys., 1: 21-8(Aug. 1966).

It is a commonplace observation that if one tries to extrapolate a function to points far away from the region where the function is known, the results may be very sensitive to slight changes in the known values. A numerical example is used to show how very serious this problem may become when one attempts to extrapolate the Born series for scattering by strong potentials. (auth)

7563 DISPERSION THEORY FOR SYSTEM OF N NON-RELATIVISTIC PARTICLES. Alekseev, V. V. Vestn. Mosk. Univ., Ser. III Fiz. Astron., No. 1, 106-8(Jan.-Feb. 1967). (In Russian).

Even though the dispersion theory of bound states is quite well developed, there are no general linear, unequivocally solvable equations for the amplitude. The available equations may be adapted to obtain approximation formulas for specific cases, finding the actual solution by computer techniques. Such formulas were derived for the case of N nonrelativistic particles without spin, analyzing the amplitude of the system. The nature of the interacting forces does not affect applicability of the method. The derivation was based on the wave function for a system consisting of N particles. (TTT)

7564 SIMPLIFIED PROCEDURE FOR CORRECTING A MEASURED ANGULAR DISTRIBUTION OF PARTICLES FOR DISTORTION BY A SCATTERING MEDIUM. Duller, N. M. (Texas A and M Univ., College Station); Sheldon, W. R. Nucl. Instrum. Methods, 57: 355-6(Dec. 1967).

A scattering correction method is presented which simplifies the application of the convolution integral in calculating the distortion of an angular distribution of particles by a scattering medium. A series expansion of the convolution integrand permits quick access to correction terms which have clear physical interpretation. (auth)

7565 HIGH-ENERGY BEHAVIOR OF INELASTIC CROSS SECTIONS. Logunov, A. A.; Mestvirishvili, M. A.; Nguyen Van Hieu (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett., 25B: 611-14(Nov. 27, 1967).

Analytic properties of the differential inelastic scattering cross sections in cos θ are considered and some bounds for their growth in the high-energy region are established. (auth)

7566 ON THE FREEDOM IN THE DEFINITION OF REDUCED S-MATRIX ELEMENTS. Goldberg, H. (Tel Aviv, Univ., Israel). Nuovo Cim. (10), 52A: 641-61(Dec. 1, 1967).

Quasi-elastic scattering may be analysed in terms of the finite-dimensional M-matrix, which transforms the spin-space of the incoming particles into the spin-space of the outgoing ones. The relativistic discussion of this matrix involves definition of reduced S-matrix elements A(s,t; Lmab), where L, a and b are total angular momenta, and m is the z-component of L. The aforementioned definition, however, is not unique, and has 6 degrees of freedom (namely, depends on 6 parameters $\Gamma = (\gamma_1\gamma_2\gamma_3; \xi\tau\omega)$). The transition $\Gamma \to \Gamma'$ induces a unitary transformation of the A's. (A procedure for calculating this transformation is described in the Appendix.) Properties of some functions associated with the definition and the transition are discussed. Polynomials in A and A* are constructed, which are invariant under $\Gamma \to \Gamma'$. Density matrices and unitarity are briefly discussed. It is argued that discussions of analytic properties of the reduced S-matrix elements A(s,t; Lmab) must be physically meaningless, since they may change under the transitions $\Gamma \to \Gamma'$. (auth)

7567 MAJORIZATION OF FEYNMAN AMPLITUDES IN THE HIGH-ENERGY LIMIT. Cazzola, P. (Univ., Ferrara, Italy, Univ., Padua). Nuovo Cim. (10), 52A: 684-711(Dec. 1, 1967).

A majorization method of the perturbative expansion, relative to the imaginary part of the scattering amplitude at high energies in the $\lambda\varphi^3$ theory, is proposed. As an application of this method, it is shown, under plausible assumptions, that the strongest asymptotic behavior in the imaginary part of the (renormalized) scattering amplitude in the region $-m^2 < t \leq 0$ is given by the simple ladder diagrams. (auth)

7568 INTEGRAL REPRESENTATION OF WAVE OPERATORS OF SCATTERING SYSTEMS. Baumgaertel, H. (Institut fuer angewandte Matematik und Mechanik, Berlin). Monatsber. Deut. Akad. Wiss. Berlin, 9: 170-4(1967). (In German).

An integral representation is given for the wave operators of a scattering system. The representation is especially valid for comparative considerations of the time-dependent and stationary methods of the scattering theory. An example is given of the use of the representation. The analytical continuation of S-matrix and resolvents of the scattering system is considered. (tr-auth)

Particle Accelerators

Refer also to abstracts 7629 and 7630.

7569 (BARC-291) VAN DE GRAAFF LABORATORY PROGRESS REPORT. David, T. P. (comp.) (Bhabha Atomic Research Centre, Bombay (India)). 1967. 49p. Dep.

The operation and utilization of the 5.5 MeV Van de Graaff accelerator at Trombay during the year 1966 is described. Included topics are accelerator description and performance, research experiments, instrumentation and data processing, radiation survey, seminars, Indian Nuclear Data Group, and the library at the Van de Graaff Laboratories. (W.H.K.)

7570 (INFN/AE-66/6, pp 102-16) BRIEF SUMMARY OF FIELD SKETCHING TECHNIQUES. Bradamante, F.; Sauli, F. (Istituto Nazionale di Fisica Nucleare, Trieste (Italy)).

Field sketching techniques are described which allow determination of the field intensity and the equipotential surfaces of fields satisfying Laplace's or Poisson's equations. The fields interested in are magnetic fields, electric fields, and temperature fields. (B.G.D.)

7571 (ITEF-513) NALADKA REZHIMA USKORENIYA I PARAMETRY PUCHKA LINEINOGO USKORITELYA I-2. (Adjustment of Acceleration Conditions and the Beam Parameters of the Linear Accelerator I-2). Batalin, V. A.; Kapchinskii, I. M.; Lazarev, N. V.; Plotnikov, V. K.; Polyakov, B. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1967. 23p. (In Russian). Dep.

A linear strong-focusing proton accelerator was put in operation at the Institute for Theoretical and Experimental Physics. The 24.6-MeV proton beam with the pulsed current up to 130 ma was obtained. The methods of starting, the operations used for the beam intensity increase as well as the characteristics of the beam and the conditions of linac are given. The instrumentations used for the beam measurements are described. (auth)

7572 (LA-3828) MEDIUM-ENERGY PHYSICS PROGRAM. Quarterly Status Report for the Period Ending October 31, 1967. (Los Alamos Scientific Lab., N. Mex.). Nov. 1967. Contract W-7405-eng-36. 44p. Dep. CFSTI.

Recent developments at LAMPF are discussed including developments in accelerator structures, the rf power source, accelerator control and safety, accelerator physics, and the experimental area. (W.H.K.)

7573 (LYCEN-6767) ETUDE DE LA FOCALISATION DANS LES ACCELERATEURS ELECTROSTATIQUES A TRES FORT DEBIT. (Study of Focusing in Electrostatic Accelerators of Very High Charge). Burnot, Guy (Lyon Univ. (France). Institut de Physique Nucleaire). Oct. 1967. 120p. (In French). Dep.

Thesis.

The space charge effect in beams with revolution symmetry is studied. In order to complete the works of M. Barat, an application is made to Van de Graaff accelerator. The method of presenting the problem when the beam is no longer circular but elliptical is studied. An approximate study is of the focusing obtained with an electrostatic tube equiped with quadrupole magnetic lens. The resolution of equations defining the marginal trajectories of a nonrevolution beam is made more rigorous and more systematic. An analytical perturbation method is defined and its results compared with numerical calculations. These methods are applied and tested on various simple cases and particularly on the electrostatic tube equiped with quadrupole magnetic lens. The characteristic of a device permitting the efficient focusing of very intense beams is presented. (J.S.R.)

7574 (NP-17179) THE 10 TO 20 GeV CORNELL ELECTRON SYNCHROTRON. Wilson, R. R. (Cornell Univ., Ithaca, N. Y. Lab. of Nuclear Studies). May 1, 1967. 56p. Dep.

The design of the 10- to 20-GeV Cornell electron synchrotron is discussed. Included topics are tunnel and buildings, magnet design and construction, modified magnets and the quadrupoles, the lattice, magnet excitation, flat-topping, magnetic measurements, magnet survey, vacuum system, injection: electrons and positrons, rf system, controls, monitoring the beam position, adjustments and corrections, radiation damage-scrapers, ultimate energy and intensity, conversion to a 20-BeV colliding beam, construction schedule and costs, and parameters of the synchrotron. (W.H.K.)

7575 (ORNL-AIC-1) HIGH-ENERGY ACCELERATORS, 1967. Howard, Fred T. (Oak Ridge National Lab., Tenn.). Nov. 1967. Contract W-7405-eng-26. 43p. Dep. CFSTI.

The chief characteristics of over 40 major accelerator installations of the world are given: 21 proton synchrotrons, 12 electron synchrotrons, 6 linear accelerators, and 2 large isochronous cyclotron projects. Full-page data sheets describe each high energy ($E \leq 1$ GeV) accelerator, existing or under construction. Proposed machines are briefly described in tabulations for the various types. The characteristics of 7 injectors and 17 storage rings are also tabulated. (auth)

7576 (RI-1967/12) INTEGRATION COUP PAR COUP DU COURANT DE FAISCEAU D'UN ACCELERATEUR PULSE. (Step by Step Integration of the Beam Current of a Pulsed Accelerator). Truong, Thanh Khai (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). [1967]. 101p. (In French). Dep.

An integrator that can be used with all the measurement devices of the Orsay linear accelerator, even the magnetic torus, was constructed. The electronic device for the measurement of the charge by sampling was described, and its curcuits are given. The use of a sampling system with a magnetic torus meter is discussed. The principle of the system is given, and its operation in aperiodic and oscillating regimes is described. (J.S.R.)

7577 (UCRL-17939) EXPERIMENTAL USE OF THE 200 GeV ACCELERATOR. Keefe, Denis (California Univ., Berkeley. Lawrence Radiation Lab.). Oct. 1967. Contract W-7405-eng-48. 18p. Dep. CFSTI.

A brief description of the background and the present status of the 200-GeV proton accelerator is presented. Experiments utilizing the 200-GeV accelerator are surveyed, and the production of secondary beams is discussed. (W.H.K.)

7578 PERIODIC FOCUSING OF DENSE ELECTRON BEAMS WITH THIN QUADRUPOLE LENSES. Szilagyi, M. (Budapest Polytechnical Univ.). pp 70-4 of Microwave and Optical Generation Amplification. IEE Conference Publication 27. London, The Institution of Electrical Engineers, 1967.

From 6th International Conference on Microwave, Optical Generation, and Amplification, Cambridge, Eng., Sept. 12-16, 1966. See CONF-660932.

An analytical treatment of a periodic focusing system for dense electron beams is presented. The focusing system consists of thin electrostatic or magnetic quadrupole lenses. (W.H.K.)

7579 LABORATORY ELECTRON GUN. Petrov, V. I.; Kobarenkov, A. P. Prib. Tekh. Eksp., No. 4, 224-6(July-Aug. 1967). (In Russian).

A laboratory electron gun of the detachable type with niobium cathodes was described. It has an electron beam current up to 40 mA and accelerating voltage up to 50 kV. (tr-auth)

7580 PRODUCTION OF MULTICHARGED GERMANIUM IONS ON STAND AND IN CYCLOTRON. Pasyuk, A. S.; Tret'yakov, Yu. P. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 4, 35-6(July-Aug. 1967). (In Russian).

An attempt to produce and accelerate in the cyclotron multicharged germanium ions from an arc source with a heated cathode was made. The average current of $^{70}Ge^{8+}$ ions accelerated on the 3rd harmonic was 1 μA. (tr-auth)

7581 PRODUCTION OF A BEAM OF NEGATIVE HYDROGEN IONS WITH ENERGY UP TO 1.5 MeV AND CURRENT UP TO 1 mA. Dimov, G. I.; Timoshin, I. Ya.; Demidov, V. V.; Dudnikov, V. G. (Inst. of Nuclear Physics, Novosibirsk, USSR). Prib. Tekh. Eksp., No. 4, 30-4(July-Aug. 1967). (In Russian).

A pulse beam of negative hydrogen ions with current up to 1 mA and duration up to 1.5 msec was obtained from the electrostatic accelerator at 1.5 MeV. The H^- source and the energy stabilization system were described. (tr-auth)

7582 ECONOMICAL SOURCE OF NEGATIVE TRITIUM IONS. Khirnyi, Yu. M.; Kochemasova, L. N. Prib. Tekh. Eksp., No. 4, 25-9(July-Aug. 1967). (In Russian).

The results of the operation of the duoplasmatron source of negative ions in different gas mixtures of hydrogen with He, Ne, Ar, N_2, and Xe were described. It was shown that the addition of Xe promotes the increase of the efficiency of the working gas and can reduce the specific tritium yield of the source to 0.15 $cm^3/\mu A \cdot hr$. The economic method of the working gas can be used in operation of the source in other active products. (tr-auth)

7583 LIMITING CURRENT IN LINEAR ACCELERATORS. Bondarev, B. I.; Pashkovskii, V. V. Prib. Tekh. Eksp., No. 4, 24-5(July-Aug. 1967). (In Russian).

The integral equation for the calculation of the limiting current in linear proton accelerators in cylindrical approximation of the accelerated bunch was examined. It was shown that the correct solution gives not only qualitative but good quantitative agreement with approximate analytical solutions obtained earlier. (tr-auth)

7584 DOUBLED MICROTRON. Belovintsev, K. A.; Borisov, A. V.; Kostyukov, S. I.; Lapchinskii, V. G.; Lebedev, V. I.; Cherenkov, P. A. (Inst. of Physics, Moscow). Prib. Tekh. Eksp., No. 4, 22-3(July-Aug. 1967). (In Russian).

The construction of a doubled microtron, used for the simultaneous acceleration of two electron beams in the microtron regime was described. The possibility of using the device for the production and acceleration of electron and positron beams was shown. The basic characteristics of the microtron and the results of ignition tests are reported. The microtron presents interest as an independent device and as an injector for synchrotron storage rings. (tr-auth)

7585 CALCULATION OF A SECTIONED ACCELERATOR TUBE WITH INCLINED FIELDS. Serbinov, A. N.; Mazhulin, A. V. (Inst. of Physico-Energetics, Obninsk, USSR). Prib. Tekh. Eksp., No. 4, 19-21(July-Aug. 1967). (In Russian).

A scheme for the construction of an ALGOL-program for the calculation of a sectioned accelerator tube with inclined fields was described. The results of the calculation of the sectioned tube for the electrostatic accelerator EG-2.5 are reported. (tr-auth)

7586 DETACHABLE ELECTRON GUN. Knyazev, B. R.; Vishnyakov, V. A. (Physical-Technical Inst., Kharkov). Prib. Tekh. Eksp., No. 4, 222-3(July-Aug. 1967). (In Russian).

The construction of the electron gun with tungsten cathodes, erected on a standard high voltage insulator, was described. (tr-auth)

7587 RECENT DEVELOPMENT OF MAGNET EQUIPMENT FOR USE IN RESEARCH WORK. Gotoh, Masayuki; Akiba, Toshimitsu (Mitsubishi Electric Corp., Japan). Mitsubishi Denki Lab. Rep., 41: 481-7(Mar. 1967). (In Japanese).

Magnet equipment forming physical instruments and their attendant apparatus have come into a series of electric apparatus as basic products turned out in Kobe Works and its associated plants. An achromatic system for a beam transport channel of particle accelerator, high resolution or broad range reaction analyzers, and large aircore β-ray spectrometers and the like have been developed to meet the demands of several universities and national research institutes, thus the technique concerning the equipment has been firmly established. Those given above have undergone the assembling tests at the factory and some of them are operating at the purchasers' laboratories with successful results as anticipated. (auth)

7588 RF MEASUREMENTS OF ACCELERATING STRUCTURES OF AN ELECTRON LINEAR ACCELERATOR. Nakamura, Masao (Min. of Int. Trade and Ind., Japan). Denki Shikenjo Kenkyu Hokoku, No. 672, 1-70(Feb. 1967). (In Japanese).

A method and some results of microwave cold measurements of ETL 25-MeV electron linear accelerator are reported. The accelerator, first operated late in 1963, is of ordinary disk loaded accelerating structure designed to operate in $2\pi/3$ mode at 2856 Mc/s. The method consists of measurements of resonant frequency of a cavity formed by two shorting plungers with or without frequench perturbation caused by a bead. The shorting plunger method adopted here is a modification of a similar method used for impedance measurements of accelerating structures, though the latter needs only one plunger. The idea using two shorting plungers to form a resonant cavity within an accelerating structure was first brought out by Tosiba linac group and was preliminarily tested by them. The method was examined experimentally and the data were analyzed. The main concern was a critical review of the method mentioned above. Also given is an account of a relation of rf parameters to the beam characteristics, some optimum design criteria, implication of cavity tuning and evaluation of beam characteristics of ETL linac using data obtained by cold tests. The method reported is a convenient and practical method if it is used with care, but for precise measurements and less impairment of the structure under measurements, a method involving measurements of amplitudes and phases of reflected signals caused by a bead in a travelling wave will be superior. (auth)

7589 NEW 160-cm CYCLOTRON FOR THE INSTITUTE OF PHYSICAL AND CHEMICAL RESEARCH. Ashihara, Etsuro; Masuda, Takahisa (Tokyo Shibaura Electric Co., Ltd.). Toshiba Rebyu, 22: 718-26(June 1967). (In Japanese).

A new variable-energy cyclotron was installed by Toshiba at the Institute of Physical and Chemical Research in the spring

last year, and have been commissioned after the acceleration test of heavy ions. Almost all parts of the cyclotron were manufactured by Toshiba, on the basis of the Institute's design, as an extension of the 160-cm cyclotron of the Institute for Nuclear Study, Tokyo University, which had been constructed by Toshiba. The new cyclotron differs from the I.N.S. unit in accelerating heavy ions, in addition to protons, deuterons and alpha particles. The main electromagnet weighs about 350 tons, having pole tips measuring 162 cm in diameter and magnetic induction of 0.5 to 2.0 Wb/m^2. Its rf system is designed to have a frequency range of 5.5 to 13.5 Mc, so that the earth plates, the shorting bar on the Lecher type stem and the coupling loops may all be moved remotely. (NSA of Japan)

7590 ELECTROLYTIC PREPARATION OF CYCLOTRON TARGETS OF RARE EARTH METALS. Roemer, J.; Ross, R. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Isotopenpraxis, 3: 341-2(1967). (In German).

In preliminary studies the precipitation of rare earths from 0.01 N HNO_3 gave voluminous precipitates which after drying flaked off of the support. Solid adhering layers could be obtained when mixtures of 0.01 N HNO_3 and organic solvents were used as the electrolyte. The organic solvents ethynol, butanol, and acetone were tested. Homogeneous layers could be obtained when the precipitation was made without stirring. The effect of precipitation time, current density, and organic solvent on the adhesiveness of the precipitated rare earth were determined. (J.S.R.)

7591 DEPOLARIZATION DUE TO MAGNETIC FOCUSSING OF POLARIZED PARTICLES. Werren, D. W. (Rijksuniversiteit Groningen, Netherlands). Nucl. Instrum. Methods, 58: 84-9(Jan. 1968).

If a magnetic multipole lens is used to focalize polarized charged particles some depolarization occurs due to Larmor precession. For a quadrupole lens the existing symmetries are discussed and a calculation method is presented. The effect amounts to a few parts per thousand of the initial degree of polarization. (auth)

7592 SOURCE OF POLARIZED PROTON AND DEUTERON BEAMS. Valyi, L. (Central Research Inst. for Physics, Budapest). Nucl. Instrum. Methods, 58: 21-8(Jan. 1968).

The possibility of the polarization in spin of atomic hydrogen and deuterium beams at thermal energies excited to the metastable $2S_{\frac{1}{2}}$ state has been investigated. The method for the production of polarized proton and deuteron beams is described. The tensor polarization of the deuteron beam, as evaluated from the asymmetry observed on the angular distribution of the neutrons from the $T(d,n)^4He$ reaction, was found to be $P_{33} = -0.294$. (auth)

7593 BUNCHED nsec BEAM PULSES OF HEAVY IONS UP TO MASS 32 WITH A HVEC TANDEM ACCELERATOR. Ischenko, G.; Jaeschke, E.; Reichardt, W.; Arnold, W.; Braunecker, B. (Erlangen-Nuernberg Univ., Ger.). Nucl. Instrum. Methods, 58: 170-2(Jan. 1968).

Negatively charged O_2 and H dc ion beams from the HVEC ion source were modulated with rf frequencies of 3 and 10 Mc/s. Beam pulses of 18 MeV ^{16}O ions 6.8 nsec wide and of 6 MeV protons 7.0 nsec wide were measured with bunching factors of 13.5 respectively 8.0. (auth)

7594 UNIVERSAL ION SOURCE FOR TANDEM ACCELERATORS. Heinicke, E.; Bethge, K.; Baumann, H. (Univ., Heidelberg). Nucl. Instrum. Methods, 58: 125-33(Jan. 1968).

Two versions of a Penning ion source were investigated to extract negatively charged ions either axially or radially. The operating conditions were investigated by measurements with Langmuir probes in the positive column of the discharge. With these results, the production of some negative molecule ions could be explained. The extracted ion currents of negative as well as positive ions are listed in a table. (auth)

7595 AUTOMATIC TIMING AND CONTROL SYSTEM FOR ACTIVATION EXPERIMENTS WITH PARTICLE ACCELERATORS. Black, J. L.; Mahieux, J. (Stanford Univ., Calif.). Nucl. Instrum. Methods, 58: 93-101(Jan. 1968).

An automatic timing and control system for general activation experiments with particle accelerators was built and tested. The system is designed for half lives in the range from 1 ms to approximately an hour. (auth)

7596 A LINEARIZED Q-METER CIRCUIT FOR MEASUREMENT OF HIGH PROTON POLARIZATION IN A TARGET. Petricek, V. (Nuclear Research Inst., Czechoslovak Academy of Sciences, Rez). Nucl. Instrum. Methods, 58: 111-16(Jan. 1968).

A proposal and theoretical analysis of a new Q-meter circuit for the measurement of high proton polarization is given. It is shown that a Q-meter of this kind, equipped with an automatic resonant-frequency control, is suitable for more accurate measurement of proton polarization than other methods. (auth)

7597 DEVELOPMENT OF SUPER-HIGH ENERGY (1000 GeV) PROTON SYNCHROTRON. Mints, A. L.; Vasil'ev, A. A.; Burshtein, E. L. At. Energ. (USSR), 23: 432-8(Nov. 1967). (In Russian).

A 1000 GeV proton accelerator with an intensity of 3 to 10×10^{13} particles/pulse and pulse frequency of 0.3 Hz is described The 1000 GeV accelerator is fed by an 18 GeV ring accelerator with intensity of 2 to 6×10^{12} particles/pulse and pulse frequency of 20 Hz which is fed by an 800-MeV linear accelerator with a current of 100 mA, pulse duration of 10 msec, emittance of 6×10^{-4} rad. cm, and pulse frequency of 20 Hz. (R.V.J.)

7598 LOW COST DEUTERATED POLYETHYLENE TARGETS OF CONTROLLED THICKNESS FOR HIGH CURRENT ACCELERATORS. Olivo, M. A.; Bailey, G. M. (Univ. of British Columbia, Vancouver, Can.). Nucl. Instrum. Methods, 57: 353-4(Dec. 1967).

Thin copper backed deuterated polyethylene targets were prepared and their performance and characteristics compared with commercial deuteride targets. (auth)

7599 TROCHOIDAL INJECTION OF IONS IN THE CENTER PLANE OF THE SACLAY CYCLOTRON. Beurtey, R.; Durand, J. M. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Instrum. Methods, 57: 313-20(Dec. 1967). (In French).

A system is described which permits the injection of an externally generated beam of low energy ions into the center of the cyclotron. The method involves a compensation of the magnetic force by an electrostatic field. The system is very flexible and permits one to obtain beams of 30 nA of polarized protons in the experimental area. (auth)

7600 DESIGN OF DOUBLE MUSHROOM MAGNETS. Bosi, G. (Univ. of Moncton, Can.). Nucl. Instrum. Methods, 57: 271-3(Dec. 1967).

The results of previous papers are criticized and modified in order to take into account the influence of exciting coils in the design of electromagnets. As theoretical data are available for axially symmetric systems, double mushroom arrangements are considered. The absence of local saturation is assumed for deriving ideal pole shapes and field forms. (auth)

7601 PLUNGING MECHANISM FOR NIMROD PROTON ACCELERATOR. Burnett, C. A. (Towler Hydraulics, Rodley, Eng.). Engineer, 224: 650-2(Nov. 17, 1967).

The high-speed plunging mechanism which deflects the proton beam into experimental areas by moving a magnet weighing 1 ton accurately over a distance of 20 in. in times as short as 0.35 sec. is described. The mechanism employs an oil hydraulic system which incorporates a new design of variable-displacement swash-plate pump. (UK)

7602 ELECTRON OPTICAL SYSTEMS WITH FIXED IMAGE POSITIONS FOR BEAMS OF VARIABLE ENERGY. Cross, J. D.; Read, F. H.; Riddle, E. A. (Univ. of Manchester, Eng.). J. Sci. Instrum., 44: 993-6(Dec. 1967).

Two electrostatic electron optical systems are discussed. The first system is based upon the known parameters of a double aperture lens and the second is an empirical design. Experimental results are presented which show that it is possible to operate these two systems in such a way that, with a constant position and energy of the initial object, the position of the final image can be kept very nearly constant when the energy of the electrons forming the image varies over a wide range. (auth)

7603 SUPERCONDUCTING MAGNETS IN HIGH ENERGY PHYSICS. Smith, P. F.; Thomas, D. B. (Rutherford High Energy Lab., Chilton, Eng.). Nature (London), 216: 964-9 (Dec. 9, 1967).

Magnets play a large part in the study of elementary sub-nuclear particles. Advances in the technology of superconducting magnets suggest that these magnets will be an important factor in the design of future accelerators, and their associated experimental equipment. (auth)

7604 BETATRON. Suematsu, Shigeru; Masuda, Masami (to Hitachi Ltd.). Japanese Patent 1966-10560. May 18, 1966. Filed Sept. 9, 1964.

An improved betatron is proposed. Two correction coils for the magnetic shunt are installed, one between the upper side of the doughnut tube and the lower side of the upper magnetic pole, and the other between the lower side of the doughnut tube and the upper side of the lower magnetic pole. Each coil is attached on the (outer) surface of the doughnut tube, directly above (and below) the magnetic shunt which is located near the protrusion of the doughnut tube for withdrawing accelerated electrons. (NSA of Japan)

7605 BETATRON. Suematsu, Shigeru; Masuda, Masami (to Hitachi Ltd.). Japanese Patent 1966-10557. May 18, 1966. Filed Sept. 9, 1964.

In the betatron proposed, an improvement is made to the position of installation of the contraction coils, thereby increasing the efficiency of the betatron. The betatron, as is usual, consists of the upper and lower central cores excited by an alternating current; the doughnut-type accelerating tube held between the two magnetic poles; the component connecting together the two poles; and the contraction coils for disturbing appropriately the magnetic field when electrons are injected. The contraction coils are installed on the upper and lower sides of the doughnut, exactly above and below the stable accelerating orbit. (NSA of Japan)

7606 IRRADIATION DEVICE FOR A BETATRON. Takahama, Takeshi; Masuda, Masami (to Hitachi Ltd.). Japanese Patent 1966-10559. May 18, 1966. Filed Sept. 9, 1964.

An improved irradiation device for a betatron is described. The irradiation device includes the following: the betatron proper, a horseshoe-shaped support between the arms of which the betatron is held rotatable around the horizontal axis, a disc connected to the horseshoe-shaped support located over the latter, which rotates the support (i.e., its two arms), the crane which suspends the disc etc, a device installed on the outside of one arm of the horseshoe-shaped support, for slanting the betatron, and a pulse transformer installed on the outside of the other arm. (NSA of Japan)

7607 BETATRON. Suematsu, Shigeru; Masuda, Masami (to Hitachi Ltd.). Japanese Patent 1966-10558. May 18, 1966. Filed Sept. 9, 1964.

A betatron is described wherein a discharge originating from the lead wire to the electron gun is prevented. A discharge preventive plate in the shape of U in the cross section is installed, surrounding the protrusion in which an electron gun with the lead wire is located. The three sides of the U plate are in contact with the yoke and the coil wound parts of the magnetic poles, respectively. (NSA of Japan)

7608 BETATRON. Masuda, Masami; Suematsu, Shigeru (to Hitachi Ltd.). Japanese Patent 1966-10556. May 18, 1966. Filed Sept. 9, 1964.

A betatron is described whereby the expansion coil is protected from the dielectric breakdown due to the heating. It includes the following: the circular accelerating tube, the two central magnetic poles, which hold from above and below the accelerating tube, the component, connecting the two magnetic poles located through the middle space of the circular accelerating tube, and the expansion coil which is installed on the outer surface of the circular accelerating tube opposed to the central component. (NSA of Japan)

7609 CHARGED-PARTICLE ACCELERATING TUBE. Aihara, Ryuzo (to Sumitomo Electric Industries Ltd.). Japanese Patent 1967-2080. Feb. 7, 1967. Filed Nov. 19, 1963.

A charged-particle accelerating tube is described whereby the effect of an external magnetic field can be eliminated by use of peculiar accelerating electrodes. In accelerating tubes, this is usually done by installation of electric-wire loops around the tube, whereby the correcting magnetic field is produced; this requires considerable equipment. In the proposed method, the accelerating electrodes of a magnetic material are employed so as to surround completely the axial, center-line of the accelerating tube. (NSA of Japan)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 6601, 6799, 7337, and 7630.

7610 (ANL–7319) CANDID-1D: A ONE-DIMENSIONAL, MULTIGROUP DIFFUSION-THEORY PROGRAM FOR THE CDC-3600. Zeman, J. L.; Greenspan, H.; Butler, M. K. (Argonne National Lab., Ill.). May 1967. Contract W-31-109-eng-38. 42p. Dep. CFSTI.

The computer program CANDID-1D, which is written in FORTRAN 63 for the CDC 3600, is described. The program can be used to solve one-dimensional problems in plane, cylindrical, and spherical geometries. The real or adjoint solution can be calculated, and homogeneous (eigenvalue) or inhomogeneous (external source) problems can be solved. Three criticality search options are provided in addition to the flux-convergence, or k_{eff}, calculation. (D.C.W.)

7611 (GA–7105) DIFFERENTIAL NEUTRON THERMALIZATION. Quarterly Technical Report, January 1, 1966–March 31, 1966. Whittemore, W. L. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Apr. 26, 1966. Contract AT(04-3)-167. 40p. Dep. CFSTI.

Doubly differential cross sections and energy-transfer cross sections for the scattering of 0.217- and 0.366-eV neutrons by liquid para-hydrogen were measured and were compared with theoretical predictions by Young and Koppel. The neutron scattering law for D_2O was also investigated. Doubly differential cross sections for neutron scattering by liquid D_2O at 0.157, 0.206, 0.304, and 0.304 were measured, together with energy-transfer cross sections for neutron scattering by a liquid D_2O-H_2O mixture at 0.404 eV. The scattering law data for D_2O were compared with theoretical predictions. (D.C.W.)

7612 (GA–7581) TOTAL CROSS SECTION MEASUREMENTS OF H_2O. Russell, J. L. Jr.; Neill, J. M.; Brown, J. R. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Dec. 13, 1966. Contract AT(04-3)-167. 22p. Dep. CFSTI.

The neutron total cross section of H_2O was measured over the energy range 0.01 to 15 eV in a time-of-flight experiment. An improvement in precision over that reported in the literature was achieved. Values of the free hydrogen cross section and of $\frac{2}{3}$ of the average kinetic energy of the bound hydrogen atom in H_2O were extracted from the data and were compared with the predictions of the Nelkin model, the Koppel anisotropic model, and the modified Haywood model. None of the models agree exactly with the data although the latter two models agree better than does the Nelkin model. (D.C.W.)

7613 (ITEF–482) OPREDELENIE RASPREDELENIYA NEITRONOV V TSILINDRICHESKOM BLOKE METODOM POSLEDOVATEL'NYKH STOLKNOVENII. (Determination of Neutron Distribution in a Cylindrical Block by a Method of Successive Collisions). Mikhailov, V. M. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1966. 32p. (In Russian). Dep.

An approximate method based on the successive generation approach is given for the solution of problems related to neutron transport in a cylindrical rod. The distribution of neutrons of an n-th generation is determined by means of three of its characteristics: the values in the center of the rod, at its surface, and the mean density over the rod. Tables are presented which simplify the numerical calculations involved. (auth)

7614 (LA-3810) THE EFFECT OF BASIC NEUTRON REACTION CROSS SECTIONS OF NITROGEN (n,n′), (n,2n), (n,γ), (n,p), AND (n,α) ON HIGH ENERGY NEUTRON PENETRATION IN AIR. Hansen, G. E.; Sandmeier, H. A. (Los Alamos Scientific Lab., N. Mex.). Oct. 1, 1967. Contract W-7405-eng-36. 19p. Dep. CFSTI.

In an evaluation of an integral quantity, one is interested in the relative sensitivity of this quantity to the basic input data. The influence of the basic reaction cross section of nitrogen, the major constituent of air, on the penetration of high energy neutrons in air is assessed. The reaction cross sections investigated are (n,n′), (n,2n), (n,γ), (n,p), and (n,α). The collision cross section is kept constant in all perturbations and the above individual reaction cross sections are assumed to become elastic scattering collisions, i.e., (n,n′) → (n,n) ..... (n,p) → (n,n). For a 10-m spherical source of 12 to 14 MeV neutrons, unperturbed and perturbed neutron fluxes are evaluated as a function of energy and distance. Numerical values for both flux and energy spectra are given at a distance of 825 m. As a representative example of integral data, the first collision dose to soft tissue is evaluated for the perturbed and unperturbed neutron flux. It is concluded that the (n,n′) → (n,n) and the (n,p) → (n,n) perturbations result in an increase of the dose by a factor of 2 whereas the (n,α) → (n,n) perturbation increases the dose by a factor of 1.8. The effect of the (n,2n) and (n,γ) perturbation causes insignificant perturbations in the first collision dose. The influence of the above perturbations in the basic nitrogen cross section data to the neutron vulnerability of nuclear weapons has also been investigated. The present report follows a previous publication including the same authors where the effect of calculational methods of the deep penetration of high-energy neutron in air has been investigated. (auth)

7615 (UCID–15249) QUANTUM MECHANICAL NEUTRON SCATTERING FORMALISM AND ITS USE IN CRITICALITY CALCULATIONS. McCormick, Norman J. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 25, 1967. Contract W-7405-eng-48. 53p. Dep. CFSTI.

A review of the mathematical approximations and associated assumptions that bring the quantum-mechanical treatment of nuclear motion and molecular binding into a tractable form is reviewed, with emphasis on the scattering law formalism. The incorporation of the scattering law formalism into the 05R Monte Carlo code for the treatment of thermal neutron cross sections is discussed. (D.C.W.)

7616 (WAPD-TM–671) MO807: A DIFFUSION THEORY FITTING PROGRAM USING FORTRAN-IV. Rutherford, C. H. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Sept. 1967. Contract AT(11-1)-Gen-14. 10p. Dep. CFSTI.

A computer program used to obtain fitted diffusion theory constants in which certain integrals of a diffusion theory solution are matched with those of a higher-order approximation to transport theory is described. (auth)

7617 PRESENT STATUS OF NEUTRON SOURCE STANDARDIZATION IN INDIA. Shahani, M. G.; Jain, N. C.; Sharma, D.; Gupta, U. C. (Atomic Energy Establishment, Trombay, India). pp 35-50 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

In order to establish national neutron standards, two Ra–Be sources were calibrated using the gold-foil activation technique and the BF_3 chamber technique. It is concluded that the gold-foil and BF_3 techniques are laborious and time-consuming and require more corrections as compared with the manganese sulfate bath technique. (S.F.L.)

7618 PULSED NEUTRON RESEARCH. I. Yamamuro, Nobuhiro; Kanda, Yukinori. (Tokyo Inst. of Technology). Tokyo Kogyo Daigaku Gakuko, No. 77, 27-39(1966).

A 400 keV Cockcroft–Walton-type pulsed-neutron source was constructed at the Tokyo Institute of Technology. The main specifications are the pulse widths of approximately 10 nsec and 5 μsec to 100 μsec, and the repetition frequency of 1 to 10 p/sec. It can be used for experiments with both thermal and fast neutrons. With this facility, the diffusion parameters for graphite were measured; the results obtained agreed well with those obtained by other workers. A measurement was also made on the prompt-neutron decay constant for a 20% enriched, light-water subcritical assembly. The results agreed with those calculated by use of the codes MUFT and TEMPEST. (NSA of Japan)

7619 MEASUREMENT OF REACTOR NEUTRON ENERGY DISTRIBUTION TO ~20 MeV. Kukhtevich, V. I.; Trykov, L. A.; Trykov, O. A. At. Energ. (USSR), 23: 191-5(Sept. 1967). (In Russian).

The spectra of the reactor investigated were measured at energies up to 19.5 ± 0.6 MeV using a scintillation spectrometer with a stilbene crystal and discrimination of the γ background during the excitation using filters of lithium hydride (21.4 g/cm²) under conditions of good geometry. Some deviations of the measured energy distribution from the calculated and experimental fission spectra can be explained on account of the interaction of neutrons with the materials of the active zone. With transmission coefficients up to 10^{-3} to 10^{-4}, the total cross section was measured for water, carbon, and lead in the energy interval from 1 to 9 MeV with errors of 2.5 to 3% at $1.5 < E_n < 6$ MeV and 5 to 6% at $E_n > 6$ MeV. The total cross section for carbon and water at $E_n > 2$ MeV

satisfactorily agrees with published data. For lead and water below 2 MeV, the sizes of the cross sections are lower (in comparison with the data for thick samples), which is explained by the passage of neutrons through the minimum value of the cross section. For lead in the energy range above ~3 MeV, a tendency to irregularities was observed. The dependence of the luminescence of the stilbene crystal on the energy made it possible to determine the scattering from carbon samples. (tr-auth)

7620 STANDARD FISSION NEUTRON SOURCE. Kool, J.; Mijnheer, B. J.; Aten, A. H. W. Jr. (Inst. for Nuclear Physics Research, Amsterdam). Actinides Rev., 1: No. 1, 121-3(Sept. 1967).

A fission neutron source containing approximately 1 μg of ^{252}Cf is described. A Cf mixture (containing isotopes with mass numbers 249, 250, 251, and 252) which had been purified by an extraction chromatography procedure, was deposited by evaporation onto a 26.2 μ thick gold foil, 22 mm in diameter. After evaporation, the foil was placed on an identical gold foil and both foils folded together and rolled into a cylindrical shape. A third rectangular gold foil (approx. 10 × 14 mm) was wrapped around it in order to ensure a good fit into the hole of the cylindrical monel container. Between three monel containers, gold foils provide two vacuum-tight seals. Additional sealing was achieved by applying an extremely small amount of high vacuum sealing wax on the outermost screw thread. The final dimensions of the source are identical to those of standard Ra/Be sources (15 mm OD, and 15 mm height). (S.F.L.)

7621 NEUTRON SOURCE FOR USE WITH A VARIABLE ENERGY CYCLOTRON. McKee, J. S. C. (Univ. of California, Berkeley). Contract W-7405-eng-48. Nucl. Instrum. Methods, 57: 179-80(Dec. 1967).

A design for a neutron source, using the d-d reaction is described. This source incorporates a tantalum hemisphere as the exit window and may be operated at a pressure of 10 atm. (auth)

7622 SCATTERING OF SLOW NEUTRONS ON WATER. Pucher Michel. (Technische Hochschul, Stuttgart). Nukleonik 10: 129-41 (Sept. 1967). (In German).

The influence of the Nelkin approximations of free translation and isotropically delayed rotation of the transition cross section of slow neutrons was investigated for light water. The translational motion of the water molecule was described by a crystal model with Debye and Einstein frequency spectra and the delayed rotation by two oscillators of different energy whose orientations were exactly determined. The numerical results show clearly separated effects and improvement in comparison with the experiments on the basis of the scattering law S (α,β), the angular distribution, and the total effective cross section. For heavy water the interference effect of the scattering of slow neutrons was investigated. The approximation to the mean on the molecular orientation for the inner molecular interference was reduced to a simplified and improved approximation. It was shown that the intermolecular interference with respect to the dynamic scattering properties can be calculated with the elastic scattering fraction of a crystal model and with respect to the spatial atomic distribution with the pair distribution function of the O_2 atom and the deuterons. The numerical calculation of the various pair distributions was made according to the model by the H_2 structure using the O_2 pair distribution determined by x-ray scattering. The comparison of theory with experiment on the basis of angular distribution and the total cross sections gave agreement. By direct application of the angular distribution of the x-ray scattering, pair distributions could be determined, which also described neutron scattering quite well. (tr-auth)

7623 COLD NEUTRONS. Pearce, D. G. (Atomic Energy Research Establishment, Harwell, Eng.). Sci. J., 3: 55-60 (Aug. 1967).

Some techniques for filtering reactor neutrons to obtain cold neutrons in sufficient intensities for physics experiments requiring cold neutrons are described. (D.C.W.)

7624 THE THERMAL-NEUTRON MILNE PROBLEM. Lancefield, M. J.; Schofield, P. (Atomic Energy Research Establishment, Harwell, Eng.). Brit. J. Appl. Phys., 18: 1497-1515(Nov. 1967).

A variational principle devised originally for the isotropic Milne problem without capture was developed for anisotropic scattering. The theory is described for linear anisotropy, but the extension to higher-order-anisotropy is, in principle, straightforward. The flux in the energy-dependent problem is expressed in terms of the corresponding one-velocity solution; as a result some new one-velocity half-space Green functions are introduced. A variational principle for the extrapolation length may be written, and the angular distribution of emergent neutrons can be determined by iterating the trial function. Results are presented for both isotropic and anisotropic scattering models. Using linearly anisotropic scattering, there is excellent agreement with experiment, except at grazing incidence, for the spectrum emerging from a water surface. (auth) (UK)

7625 FINITE-GEOMETRY AND POLARIZED MULTIPLE-SCATTERING CORRECTIONS OF EXPERIMENTAL FAST-NEUTRON POLARIZATION DATA BY MEANS OF MONTE CARLO METHODS. Aspelund, O.; Gustafsson, B. (Aktiebolaget Atomenergi, Studsvik, Sweden). Nucl. Instrum. Methods, 57: 197-218(Dec. 1967).

After an introductory discussion of various methods for correction of experimental left-right ratios for polarized multiple-scattering and finite-geometry effects, necessary and sufficient formulas for consistent tracking of polarization effects in successive scattering orders are derived. The simplifying assumptions are then made that the scattering is purely elastic and nuclear, and that in the description of the kinematics of the arbitrary scattering μ only one triple-parameter (the so-called spin-rotation parameter $\beta^{(\mu)}$) is required. Based upon these formulas a general discussion of the importance of the correct inclusion of polarization effects in any scattering order is presented. Special attention is then paid to the question of depolarization of an already polarized beam. Subsequently, the afore-mentioned formulas are incorporated in the comprehensive Monte Carlo program MULTPOL, which has been designed so as to correctly account for finite-geometry effects, in the sense that both the scattering sample and the detectors (both having cylindrical shapes) are objects of finite dimensions located at finite distances from each other and from the source of polarized fast-neutrons. A special feature of MULTPOL is the application of the method of correlated sampling for reduction of the standard deviations of the results of the simulated experiment. Typical data of performance of MULTPOL have been obtained by the application of this program to the correction of experimental polarization data observed in n + ^{12}C elastic scattering between 1 and 2 MeV. Finally, in the concluding remarks the possible modification of MULTPOL to other experimental geometries is briefly discussed. (auth)

7626 VARIATIONAL PRINCIPLE OF THE NEUTRON TRANSPORT THEORY AND PSEUDOENTROPY PRODUCTION. Helmis, G. (Institut fuer Magnetohydrodynamik, Jena, Ger.). Monatsber. Deut. Akad. Wiss., Berlin, 9: 186-91(1967). (In German).

The relation between the variational principle of reactor theory and the principle of the minimum pseudoentropy production was derived by assuming a very simple model of the processes in the reactor. Usually, however, there is a qualitative relation between the two principles according to the usual model. (J.S.R.)

7627 DOPPLER EFFECT EVALUATION BY A MODIFIED P_n METHOD. Fouad, Hussein Yehya. Lafayette, Ind., Purdue University, 1967. 213p.

A modified P_n method was developed to calculate the Doppler effect for systems in which there is anisotropic scattering and nonuniform temperature distributions. By means of a matrix transformation, it is possible to decouple the differential equations which result from the P_n or S_n decomposition of the Boltzmann neutron transport equation. As a result of this decoupling, it is possible to obtain an alternative solution. A computer code was written in FORTRAN IV language. Results from sample calculations indicate that the uniform effective temperature distribution approximation in fuel may underestimate the Doppler effect for thick elements. (Disser. Abstr.)

7628 PROCEDURE FOR EVALUATING MODIFIED PULSED SOURCE EXPERIMENTS IN SUBCRITICAL NUCLEAR REACTORS. Masters, Christopher Fortune. Ithaca, N. Y., Cornell Univ., 1966. 125p.

Thesis

A theoretical interpretation of the modified pulsed source experiments of Sjostrand, Gozani, and Garelis and Russell is given using the exact steady-state Boltzmann equation. The interpretation is based on a phenomenological description of the experiments and is patterned after work done on the Garelis-Russell method by Corngold. The basic approximation made is that the fundamental prompt mode decay constant is much larger than any delayed neutron precursor decay constant. The theoretical interpretation allows the reactivities measured by the above three modified pulsed source techniques to be easily calculated and compared to more conventional definitions of reactivity. The calculations can be performed by any standard source-iteration criticality code which has been modified to solve the inhomogeneous problem. Experiments were performed on the Cornell University Critical Assembly and interpreted with the aid of the above theory. Calculations and experiments agree to

within 10%. Sjostrand's method is found to give the best result for this reactor. (Disser. Abstr.)

Nuclear Properties and Reactions, A≤5

Refer also to abstract 7763.

7629 (COO-7-0440) [NUCLEAR PHYSICS]. Technical Progress Report. (Wisconsin Univ., Madison). Oct. 1967. Contract AT(11-1)-Gen-7. 14p. Dep. CFSTI.

Developments in the research program in nuclear physics are summarized, and a listing of publications that give the details of the work is presented. The development of ion sources for the tandem Van de Graaff accelerator is also covered in the same manner. (D.C.W.)

7630 (SC-RR-67-346) ABSOLUTE DETERMINATION OF 14-MeV NEUTRON YIELDS. Fewell, T. R. (Sandia Corp., Albuquerque, N. Mex.). Aug. 1967. Contract AT(29-1)-789. 35p. Dep. CFSTI.

The problem of determining the absolute yield of neutrons from the T(d,n)α reaction is examined. Techniques are developed for determining the number of neutrons produced in a TiT target per α particle emitted into any solid angle. The formulas developed can be used for various α detector locations and deuteron beam energies. The techniques are also extended to handle unanalyzed beam conditions. Geometry considerations and other problems are also discussed. The absolute accuracy of these techniques is established for the optimal target assembly of two α detectors located at 90 degrees and 135 degrees with respect to the accelerated deuteron beam. (auth)

7631 PHOTODISINTEGRATION OF THREE-PARTICLE NUCLEI. Barbour, I. M. (Glasgow Univ.); Phillips, A. C. Contract AT(30-1)-2098. Phys. Rev. Lett., 19: 1388-90(Dec. 11, 1967). (MIT-2098-379).

A new three-nucleon bound-state wave function is introduced, and the Faddeev equations and a low-energy separable approximation are adopted for the continuum states. The dependence of the total cross section for the reaction ^{3}He(γ,n)2p on the structure of the final scattering state is studied; theoretical predictions for the cross sections of the reactions ^{3}He(γ,d)p and ^{3}He(γ,n)2p are compared with experimental data. (D.C.W.)

7632 STUDY OF ^{3}H + ^{3}H, ^{3}H + ^{3}He, AND ^{3}He + ^{3}He SYSTEMS WITH THE RESONATING-GROUP METHOD. Thompson, D. R.; Tang, Y. C. (Univ. of Minnesota, Minneapolis). Nucl. Phys., A106: 591-609(1968).

The ^{3}He + ^{3}He, ^{3}H + ^{3}H, and ^{3}He + ^{3}H systems are examined using the resonanting-group method with a one-channel approximation. A two-body central potential which fits the low-energy nucleon-nucleon scattering data is used. The radii of the clusters are fitted according to experimental data. The result shows that the agreement between the calculated and experimental differential cross sections is good for the ^{3}He + ^{3}He and ^{3}H + ^{3}H systems but is only fair for the ^{3}He + ^{3}H system. The calculated phase shifts are analyzed with a one-level formula, and a number of P- and F-resonant levels in the compound nuclei ^{6}He, ^{6}Li and ^{6}Be are found. The question about the existence of excited states below the ^{3}He + ^{3}He, ^{3}H + ^{3}H and ^{3}He + ^{3}H thresholds was also examined. Here, the result shows that many S- and D-levels do exist in these energy regions. (auth)

7633 NEUTRON-NEUTRON COINCIDENCE SPECTRA FROM THE ^{2}H(n,2n)^{1}H REACTION AT 14.1 MeV. Honecker, R.; Graessler, H. (Technische Hochschule, Aachen). Nucl. Phys., A107: 81-91(1968).

A "complete" experiment was performed in measuring coincidences of the two neutrons from the deuteron break-up by 14.1 MeV incident neutrons. The measurements were confined to particle configurations containing only high-energy zero-angle protons. By choosing the detector angles symmetrically at ±67.5°, coincidences were recorded for equal energies of the break-up neutrons in the range of 0.2 to 3 MeV. The coincidences were separated from the background by means of a coincidence time-of-flight arrangement containing a deuterated scintillator, which represented the target. The data were analyzed by means of the Monte-Carlo method using the Born approximation for the calculation of the break-up cross section. From the calculated curves, a value of $-18.8^{+1.5}_{-1.9}$ fm for the neutron-neutron scattering length was found to give the best agreement with the experiment. (auth)

7634 SEARCH FOR EXCITED STATES IN ^{3}He. Mancusi, M. D.; Jones, C. M.; Ball, J. B. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett., 19: 1449-51(Dec. 18, 1967).

A search for ^{3}He excited states in the reaction ^{3}He(p,p')^{3}He* with proton bombarding energy of 30.9 MeV was made. No inelastic peaks were observed. (auth)

7635 POLARIZATION AND PHASE SHIFTS IN D(p,p)D AT 3.00 MeV. Trachslin, W. (Univ., Basel. Carnegie Institution of Washington, Washington, D. C.); Brown, L.; Clegg, T. B.; Seyler, R. G. Phys. Lett., 25B: 585-7(Nov. 27, 1967).

A set of phase shifts is presented that reproduces the measured polarization effects and cross section for D(p,p)D at 3.00 MeV. (auth)

7636 A LOWER LIMIT ON THE MASS OF ^{5}Be. Adelberger, E. A. (California Inst. of Tech., Pasadena); McDonald, A. B.; Tombrello, T. A.; Dietrich, F. S.; Nero, A. V. Phys. Lett., 25B: 595-8(Nov. 27, 1967).

The reaction ^{3}He(^{3}He,n) was studied at incident energies between 18.0 and 16.0 MeV to search for the "ground state" of ^{5}Be. No structure attributable to ^{5}Be was found, indicating that the "ground state" of ^{5}H is unbound to ^{3}H + 2p by at least 2.1 MeV. (auth)

Nuclear Properties and Reactions, 6≤A≤19

Refer also to abstracts 6361, 7569, 7614, 7629, 7661, 7663, 7669, 7686, and 7763.

7637 (COO-1573-33) NUCLEAR PHYSICS LABORATORY PROGRESS REPORT FOR THE PERIOD NOVEMBER 1, 1966 TO OCTOBER 31, 1967. (Case-Western Reserve Univ., Cleveland, Ohio. Dept. of Physics). Contract AT(11-1)-1573. 54p. Dep. CFSTI.

The results of experimental investigations of neutron elastic and inelastic scattering by ^{12}C, ^{59}Co, ^{63}Cu, ^{54}Fe, ^{56}Fe, ^{58}Ni, and ^{60}Ni; neutron polarization from the reaction ^{13}C(d,n)^{14}N; and fluctuations in neutron total cross sections are presented. Developments in a number of areas of nuclear theory, elementary-particle theory, and scattering theory are summarized. (D.C.W.)

7638 (JINR-E2-3600) ON THE ANGULAR CORRELATIONS IN UNIQUE MUON CAPTURE BY SPIN TARGETS. Oziewicz, Z.; Pikulski, A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 18p. Dep.

The angular correlations in the process of muon capture by nonzero spin targets followed by gamma emission are considered in the case of unique allowed and forbidden transitions. The formulas for some exceptional interesting correlation constants are given. The experimental study of these correlations may serve as a very sensitive way to determine the magnitude of the induced pseudoscalar term. (auth)

7639 (LA-3765) ELASTIC AND INELASTIC SCATTERING OF FAST NEUTRONS FROM ^{6}Li AND ^{7}Li. Hopkins, John C.; Drake, D. M.; Conde, H. (Los Alamos Scientific Lab., N. Mex.). June 1967. Contract W-7405-eng-36. 62p. Dep. CFSTI.

The differential elastic and inelastic neutron scattering cross sections of ^{6}Li and ^{7}Li were measured at incident neutron energies of 4.83, 5.74, and 7.5 MeV for ^{6}Li and at energies of 3.35, 4.83, 5.74, and 7.5 MeV for ^{7}Li. Scattered neutrons and gamma rays were observed independently. The cross sections were measured with a neutron time-of-flight spectrometer relative to the well-known cross section for neutron scattering from hydrogen. The gamma-ray spectra were measured with a NaI(Tl) spectrometer using time-of-flight techniques to eliminate the neutron background. The 2.184-MeV state in ^{6}Li was excited by neutron inelastic scattering. The 3.56-MeV state in ^{6}Li was not observed in either the neutron or gamma-ray studies. Scattered neutrons from the 0.478-MeV state in ^{7}Li were resolved at both 3.35 and 4.83 MeV. Scattered neutrons from the 4.63-MeV state in ^{7}Li were observed at incident neutron energies of 5.74 and 7.5 MeV. A continuum of neutrons due to three-particle breakup was observed for both ^{6}Li and ^{7}Li at 4.83, 5.74, and 7.5 MeV. (auth)

7640 (NYO-2028-2, pp 84-95) NUCLEAR POLARIZATION IN THE ^{11}B(d,p)^{12}B REACTION. II. Pfeiffer, Loren; Madansky, L. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics). (NYO-2028-10).

Measurements were made of the polarization of the ^{12}B recoil nuclei resulting from the ^{11}B(d,p)^{12}B reaction for E_d in the range

0.90 to 3.20 MeV. The polarization is observed by measuring the beta decay asymmetries of the ^{12}B recoil nuclei with respect to the reaction plane. The ^{12}B recoil nuclei formed in the ground state are separated kinematically from those in excited states and are then stopped in various solids in the presence of a small magnetic field normal to the reaction plane. The sign of the observed polarization for all measurements is in the direction of the vector $\vec{k}_d \times \vec{k}_p$. The magnitude of the polarization is strongly dependent on E_d, the recoil emission angle, and the material used to stop the recoils. It is found that the polarization of ^{12}B nuclei can be maintained in either metallic Pd or Au at room temperature, using holding fields smaller than 20 G. For recoils stopped in Pt metal, a magnetic field of about 200 G is required to maintain nuclear polarization. ^{12}B recoil polarization plotted as a function of E_d shows definite structure. Polarization resonances are observed at 1.5, 2.1, and 3.0 MeV. At these energies the measured relative polarizations are +8.01 ± 0.30%, +4.29 ± 0.30%, and +3.86 ± 0.27%, respectively, for a Pt metal recoil stopper and a 49° (lab) recoil angle. These resonances are tentatively identified with states of the ^{13}C compound nucleus near 20.0 MeV and at 20.52 and 21.28 MeV. It is believed that the polarization resonances may result from an interference between direct interaction and two-particle compound resonance processes. (auth)

7641 (NYO-2028-2, pp 96-105) MEASUREMENT OF THE MAGNETIC MOMENT OF ^{12}B BY NUCLEAR SPIN PRECESSION ABOUT A WEAK FIELD. Pfeiffer, Loren; Wells, John C. Jr.; Madansky, L. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics). (NYO-2028-11).

The nuclear magnetic moment of ^{12}B is obtained from a measurement of the Larmor precession frequency. Polarized ^{12}B nuclei are implanted in a Au or Pd lattice and are caused to precess about an externally applied transverse magnetic field of a few gauss. The frequency of precession is observed by monitoring the asymmetry pattern of the decay electrons as a function of time after the application of the transverse field. The Larmor precession of ^{12}B was observed in Au at 8.24, 12.21, and 15.95 G, and in Pd at 15.95 G. Under the assumption that the field at the implanted nuclei is the same as the applied field, a value of 0.976 ± 0.031 nm is obtained for the ^{12}B magnetic moment. (auth)

7642 INELASTIC SCATTERING OF ALPHA PARTICLES BY ^{9}Be AT 28.5 MeV. Fukunaga, Kiyoji; Nakamura, Hitoshi; Fujiwara, Noboru (Kyoto Univ.). J. Phys. Soc. Jap., 23: 911-15 (Nov. 1967).

Differential cross sections of the elastic scattering and the inelastic scatterings of alpha particles from ^{9}Be at the incident energy of 28.5 MeV were obtained. The angular distributions for the ground state and the 2.43-MeV state show the clear diffractive nature. For the positive-parity state, the phase relation of of the experiment does not agree with the diffraction theory; and the interaction radius is smaller than those for the ground state and the collective state. The peak at 1.7 MeV in the pulse-height spectrum is considered to be caused by a final-state interaction between the s-wave neutron and the ^{9}Be nucleus. (auth)

7643 ON QUASI-ELASTIC MECHANISM OF $(\alpha,2\alpha)$ REACTION AT LOW AND MEAN ENERGIES. Meboniya, D. V. Vestn. Mosk. Univ., Ser. III Fiz. Astron., No. 1, 114-16(Jan.-Feb. 1967). (In Russian).

The $(\alpha,2\alpha)$ reactions yield important information concerning the cluster structure of nuclei. At low and intermediate energies competing reactions may also take place; the importance of these reactions must be evaluated. Theoretical studies of various authors on the $^{9}Be(\alpha,2\alpha)^{5}He$, $^{12}C(\alpha,2\alpha)^{8}Be$ and $^{16}O(\alpha,2\alpha)^{12}C$ reactions agreed with experimental data but they relie on the specific properties of ^{9}Be and can not be conveniently generalized. J. J. Kudo's more comprehensive analysis was based on the quasielastic and superficial mechanism of the $(\alpha,2\alpha)$ reaction and the shell model of the nucleus; he succeeded in finding an agreement between the theoretical and experimental data for all three nuclei ^{9}Be, ^{12}C, and ^{16}O. His approach was further extended by refining the mathematics involved. It was found that the main part of the reaction involves a quasielastic process. Consideration of the interaction in the final state between the α particles affects the differential cross section of the $(\alpha,2\alpha)$ reactions at low and intermediate energies. (TTT)

7644 A STUDY OF POSITIVE-PARITY STATES IN ^{15}O. Gill, R. D.; Lopes, J. S.; Robertson, B. C.; Bell, R. A. I.; Rose, H. J. (Oxford Univ.). Nucl. Phys., A106: 673-88(1968).

A particle-gamma coincidence technique was used to study the positive-parity levels of ^{15}O located at 5.24 MeV ($J^{\pi} = 5/2^{+}$), 6.79 MeV and 6.86 MeV. The spins of the 6.79 MeV and 6.86 MeV levels were shown to be 3/2 and 5/2, respectively, and the multipole mixing ratios of the de-excitation gamma rays were determined with the following results: $\delta(5.24 \rightarrow 0) = +0.13 \pm 0.05$, an E3/M2 mixture; $\delta(6.86 \rightarrow 5.24) = -0.04 \pm 0.03$, an E2/M1 mixture and $\delta(6.79 \rightarrow 0) = -0.10 \pm 0.02$ or 2.2 ± 0.4, an M2/E1 mixture. The last mixing ratio indicates an exceptionally high retardation of an E1 transition in a non self-conjugate nucleus; a similar E1 retardation was previously found in the mirror ^{15}N transition. A comparison of the E3/M2, 5-MeV transition mixing ratios in ^{15}O and ^{15}N strongly suggests a collective character for the E3 components of these transitions. The results obtained, together with the corresponding results in ^{15}N, are compared with the recent theoretical work of Shukla and Brown. (auth)

7645 ELASTIC AND INELASTIC SCATTERING OF FAST NEUTRONS FROM ^{6}Li AND ^{7}Li. Hopkins, John C. (Los Alamos Scientific Lab., N. Mex.); Drake, D. M.; Conde, H. Contract W-7405-eng-36. Nucl. Phys., A107: 139-52(1968). (LA-DC-8876).

The differential elastic and inelastic neutron scattering cross sections of ^{6}Li and ^{7}Li were measured at incident neutron energies of 4.83, 5.74 and 7.5 MeV for ^{6}Li and at energies of 3.35, 4.83, 5.74 and 7.5 MeV for ^{7}Li. Scattered neutrons and gamma rays were observed independently. The cross sections were measured with a neutron time-of-flight spectrometer relative to the well-known cross section for neutron scattering from hydrogen. The gamma-ray spectra were measured with a NaI(Tl) spectrometer using time-of-flight techniques to eliminate the neutron background. The 2.184 MeV state in ^{6}Li was excited by neutron inelastic scattering. The 3.56 MeV state in ^{6}Li was not observed in either the neutron or gamma-ray studies. Scattered neutrons from the 0.478 MeV state in ^{7}Li were resolved at both 3.35 and 4.83 MeV. Scattered neutrons from the 4.63 MeV state in ^{7}Li were observed at incident neutron energies of 5.74 and 7.5 MeV. A continuum of neutrons due to three-particle break-up was observed for both ^{6}Li and ^{7}Li at 4.83, 5.74 and 7.5 MeV. (auth)

7646 EVIDENCE FOR EXCHANGE EFFECTS IN INELASTIC SCATTERING PROCESSES FROM ANGULAR CORRELATION DATA. Edwards, Steve; Assousa, G. E. (Florida State Univ., Tallahassee). Nucl. Phys., A107: 170-6(1968).

It is shown that the behavior of the angular correlation function symmetry angle ϕ_0 at backward scattering angles can be taken as evidence for exchange effects in inelastic scattering processes. The observed behavior of ϕ_0 for $\theta > 140°$ in data from $^{12}C(\alpha,\alpha'\gamma_{4.43})$ and $^{28}Si(\alpha,\alpha'\gamma_{1.77})$ at a bombarding of 22.5 MeV is similar to that which has been observed for the exchange mode in mass-transfer reactions. That the corresponding α' angular distribution data can be well represented by a PWBA exchange mode theory in this region supports this conclusion. (auth)

7647 UNBOUND NUCLIDE ^{7}B. McGrath, Robert L. (Univ. of California, Berkeley); Cerny, Joseph; Norbeck, Edwin. Phys. Rev. Lett., 19: 1442-4(Dec. 18, 1967).

The mass and width of the ^{7}B ground state were measured using the reaction $^{10}B(^{3}He,^{6}He)^{7}B$, thus completing the mass-seven isospin quartet. During the course of the experiment new values for the excitation energies of the ^{8}B second excited state and the ^{7}Li and ^{7}Be lowest $T = 3/2$ states were found. (auth)

7648 PHOTONUCLEAR REACTIONS IN CARBON AT ENERGIES BETWEEN 300 MeV AND 1000 MeV. di Napoli, V.; Dobici, F.; Forina, O.; Salvetti, F.; de Carvalho, H. G. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notas Fis., Cent. Brasil. Pisqui. Fis., 13: No. 3, 46-69(1967).

In the energy range from 300 up to 1000 MeV, cross sections for the reactions $^{12}C(\gamma,n)^{11}C$ and $^{12}C(\gamma,x)^{7}Be$ were measured using bremsstrahlung beams of the Frascati electron synchrotron by means of the activation method. The (γ,n) cross section was measured to be 1.18 ± 0.20 mbarn, in agreement with the value predicted from the photomeson model. The $^{12}C(\gamma,x)^{7}Be$ cross section found was $8 \pm 4 \times 10^{-29}$ cm^2. (auth)

7649 CORRELATIONS OF NEUTRINO AND γ QUANTA IN NUCLEAR μ CAPTURE. Bukhvostov, A. P.; Popov, N. P. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 6: 809-20 (Oct. 1967). (In Russian).

The μ-meson capture with emission of γ-quanta from the excited level of the daughter nucleus is considered. The formulas of angular correlations and circular polarization of γ-quanta at the μ-meson capture from two states of hyperfine structure and their arbitrary mixture were obtained. Of special interest is the investigation of correlation $P_2(\cos\alpha)$ (α – is the angle between the momenta of neutrino and γ-quantum) in allowed μ-capture which in a number of cases strongly depends on the contribution of pseudoscalar constant with the weak dependence on the nuclear structure. At the allowed capture with $\Delta j = 1$ from one of the states of hyperfine structure all the correlation coefficients prove to be constant numbers independent neither of the weak interaction constants nor

of the nuclear structure. The comparison of these numbers with the experiment allows one to estimate the contribution of higher forbiddennesses. Results of calculations for μ-capture by the nuclei of ^{10}B and ^{14}N are given. (auth)

7650 THE $^{11}B(p,2\alpha)^4He$ REACTION AT THE keV RESONANCE. Chen, Y. S.; Emerson, S. T.; Jackson, W. R.; Simpson, W. Dwain; Phillips, G. C. (Rice Univ., Houston, Tex.). Contract AT(40-1)-1316. Nucl. Phys., A106: 1-13(1968). (ORO-1316-44).

The $^{11}B(p,2\alpha)^4He$ reaction was studied at a bombarding energy of 163 keV to complement the previous measurements at energies of a few MeV. Many two-parameter spectra were taken, both around the $^8Be^*$ recoil axes and at selected angles away from the recoil axes. Coplanar and non-coplanar cases for the three alpha particles were studied. Analysis yields results similar to those found previously for the higher bombarding energies but in disagreement with the conclusions of Dehnhard. Strong sequential decay through the $^8Be^*$ states was observed with very little or no evidence for simultaneous three-alpha decay. (auth)

7651 SINGLE NUCLEON PICK-UP FROM ^{12}C AND ^{14}N WITH 52 MeV DEUTERONS. Hinterberger, F.; Mairle, G.; Schmidt-Rohr, U.; Turek, P.; Wagner, G. J. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys., A106: 161-76(1968).

Energy spectra and angular distributions of tritons and ^3He particles from the $^{14}N(d,t)^{13}N$, $^{14}N(d,^3He)^{13}C$, and $^{12}C(d,^3He)^{11}B$ reactions were measured at an incident deuteron energy of 52 MeV. Spectroscopic factors were extracted by means of a DWBA analysis which are in good agreement with theoretical predictions of intermediate coupling calculations. The comparison of (d,t) and (d,^{3}He) data from ^{14}N allows a spin assignment to a number of negative-parity states in ^{13}C. The results are consistent with the assumption of a 7% 2s-1d admixture in the ground-state wave function of ^{14}N. A weak j-dependence of the angular distributions is observed which is reproduced by the DWBA calculations. There is evidence for a pick-up process with inelastic excitation in the entrance channel from the $^{12}C(d,^3He)^{11}B$ reaction. (auth)

7652 TWO-PARTICLE COINCIDENCE SPECTRA FROM THE $p + {}^6Li \rightarrow p + d + \alpha$ REACTION. Valkovic, V.; Joseph C.; Emerson, S. T.; Phillips, G. C. (Rice Univ., Houston, Tex.). Nucl. Phys., A106: 138-60(1968). (ORO-T316-47)

The reactions $^6Li(p,pd)^4He$, $^6Li(p,p\alpha)^2H$, and $^6Li(p,d\alpha)^1H$ were studied at proton bombarding energies of 9 and 10 MeV. Particle mass identification was achieved by measuring the energies of two detected particles and their time-of-flight difference. The coincidence spectra were measured with fixed detector angular setting at $\theta_1 = 30°$ and with movable detector angular settings from $\theta_2 = 45°$ to $\theta_2 = 135°$. The measured coincidence spectra indicate that both sequential decay and direct knock-out mechanisms are present. The deuteron-alpha interactions in several $T = 0$ ^6Li states were observed, the most prominent being in the 2.184 MeV state. In the ^5Li system, only the ground state was observed. No proton-deuteron final state interaction corresponding to excitation energies in the ^3He system between 5.5 and 12.0 MeV was observed. (auth)

7653 SINGLE-PARTICLE WAVE FUNCTIONS OF THE ^{12}C NUCLEUS FROM ELASTIC AND QUASI-FREE ELECTRON SCATTERING. Ciofi Degli Atti, C. (Istituto Superiore di Sanita, Rome). Nucl. Phys., A106: 215-24(1968).

Using the Born approximation and the distorted-wave impulse approximation, the elastic form factor of the ^{12}C nucleus, the angular distributions, and the energy spectrum of the $^{12}C(e,e'p)^{11}B$ reaction were computed with harmonic oscillator and square well wave functions. A comparison with recent experimental data was carried out, and the difficulty to reconcile the usual analyses of elastic and quasi-free scattering was pointed out. (auth)

7654 EXCITED STATES IN ^{19}F. Zaikin, D. A. pp 9-15 of Photodisintegration of Nuclei in the Giant Resonance Region. Skobel'tsyn, D. V. (ed.). New York, Consultants Bureau, 1967.

An attempt to describe the experimental data on the positions of levels in ^{19}F and on the E3 transition probability using the collective model and taking into account the coupling between an octupole deformation of the nuclear surface and the motion of an odd nucleon located in an ellipsoidal axial field is summarized. (D.C.W.)

7655 A STUDY OF THE STRUCTURE OF THE ^{16}O AND ^{12}C γ-RAY ABSORPTION CROSS SECTIONS IN THE GIANT DIPOLE RESONANCE REGION BY THE ABSORPTION METHOD. Dolbilkin, B. S. pp 17-75 of Photodisintegration of Nuclei in the Giant Resonance Region. Skobel'tsyn, D. V. (ed.). New York, Consultants Bureau, 1967.

An investigation of the photoabsorption cross sections of ^{12}C and ^{16}O at incident photon energies of 13 to 27 MeV is discussed in detail. The absorption technique used in the measurements is outlined as is the analysis of the data. The explanation of structure in the absorption cross section on the basis of the shell model is outlined; and experimental data are compared with theoretical predictions. Information on the energy levels excited in ^{12}C and ^{16}O is included. 133 references. (D.C.W.)

7656 RADIATIVE CAPTURE IN THE REACTION $^7Li(^{16}O,\gamma)^{23}Na$. Feldman, W.; Heikkinen, D. W.; Meyerhof, W. E. (Stanford Univ., Calif.). Phys. Lett., 25B: 593-4(Nov. 27, 1967).

An excitation function of the unresolved radiative capture γ-ray transitions to the ground and first-excited states of ^{23}Na was measured for $^7Li(^{16}O,\gamma)^{23}Na$. A resonance-like structure is observed at $E_x = 25.4$ MeV ($\Gamma = 0.63 \pm 0.20$ MeV). The peak cross section is equal to 2.4 ± 0.8 μb. (auth)

7657 STUDY OF THE REACTION $^{10}B(d,3\alpha)$ AT 270 keV. Nalda, J.; Marquez, L.; Quebert, J.-L. (Bordeaux Univ.). J. Phys. (Paris), 28: 752-4(Oct. 1967). (In French).

The reaction $d + {}^{10}B = 3\alpha$ at 270 keV is well explained by a sequential mechanism via the first and second excited states of ^8Be. The angular distributions of α_0 et α_1 are not symmetric with respect to 90°. (auth)

7658 CALCULATION OF SPALLATION OF ^{12}C AND ^{16}O BY 70- TO 200-MeV PROTONS. Epherre, Marcelle; Gradsztajn, Elie (Institut de Physique Nucleaire, Orsay, France). J. Phys. (Paris), 28: 745-51(Oct. 1967). (In French).

The absolute cross sections for the production of stable and radioactive isotopes of astrophysical interest are calculated using the two-step Serber model. The spallation reactions involved are induced on ^{16}O and ^{12}C by 70- to 200-MeV protons. The cascade calculations are performed as usual, including the possibility of ejecting alpha particles. The disintegration of the excited residual nuclei left by the cascade is calculated by the Fermi statistical model (the "break up" model). The results of these calculations are displayed. (auth)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 6361, 7432, 7569, 7629, 7637, 7646, 7701, 7705, 7706, 7716, 7726, 7742, and 7783.

7659 (LYCEN-6755) ETUDE DE LA REACTION $^{40}Ca(n,\alpha)^{37}Ar$. Courbe d'Excitation de 2.90 a 5.13 MeV. Distribution Angulaire a 2.90, 3.28, et 5.13 MeV. (Study of the Reaction $^{40}Ca(n,\alpha)^{37}Ar$. Excitation Curve at 2.90 to 5.13 MeV. Angular Distributions at 2.90, 3.28, and 5.13 MeV. Abaschi, Hamadi (Lyon Univ. (France). Institut de Physique Nucleaire). July 1967. (In French). Dep.

Thesis.

The reaction $^{40}Ca(n,\alpha)^{37}Ar$ was studied at neutron energies of 5.1, 3.2, and 2.8 MeV. Previous studies made on this reaction are reviewed in order to give a comparison. The methods used for the measurement were described. The variation of the yield with the target-detector distance was used for 2.90 and 3.28 MeV and a direct method was used for 5.13 MeV. The problems posed by the measurements are considered in detail. The results are reported and are analyzed. The analysis indicated a direct interaction process at 5.13 MeV. For the lower energies, however, two hypotheses were made: one in terms of the statistical model and the other by means of the direct interaction. (J.S.R.)

7660 (NYO-2028-2, pp 128-38) INVESTIGATION OF A TIME-REVERSAL INVARIANCE TEST USING A (d,p) REACTION: GAMMA RAY ENERGY AND INTENSITY MEASUREMENTS ON THE NUCLEUS ^{58}Fe. Goldberg, D. A.; Lee, Y. K. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics).

The possibility of using the proton-gamma-gamma correlation of the cascade decay of the second excited state of ^{58}Fe, following population of that level by the reaction $^{57}Fe(d,p)^{58}Fe$, was investigated. It is concluded that the time required to perform the experiment to sufficient accuracy is unreasonably long. The energies of the first two excited states in ^{58}Fe were measured, and preliminary values of 810.7 ± 0.3 and 1674.6 ± 0.4 keV were obtained. The second excited state decays to the first excited state $54 \pm 5\%$ of the time, and to the ground state, $46 \pm 5\%$. Following the beta decay of ^{58}Co, the second excited state is populated $1.3 \pm 0.2\%$ of the time. These results are in disagreement with previously reported values. (auth)

7661 (NYO-3525-26) STUDIES OF ELECTROMAGNETIC PROPERTIES OF EXCITED STATES OF NUCLEI. Annual Progress Report for 1967. Metzger, F. R. (Bartol Research Foundation, Swarthmore, Pa.). Dec. 12, 1967. Contract AT(30-1)-3525. 16p. Dep. CFSTI.

Through resonance scattering experiments utilizing the γ radiation from gaseous sources, it was demonstrated that the Coulomb explosion of molecules following electron capture can provide the velocities necessary for the compensation of the γ recoil energy losses. This new technique was then used to accurately determine the strength and the multipole mixing of the 1.115-MeV transition in ^{65}Cu. Other resonance fluorescence experiments made use of the Doppler-broadened γ rays from nuclear reactions or the Doppler-shifted radiation from sources moving at high velocities in the Bartol High Speed Rotor Facility. Levels in ^{40}Ca, ^{64}Zn and/or ^{66}Zn, and ^{124}Te were excited. These experiments led to unambiguous spin assignments for some of these states and provided information concerning the widths of these levels. Theoretical work was performed on the isospin dependence of the electric dipole strength in nuclei as well as on the distribution of the radiative width among the fine structure states of an isobaric analog resonance. The possible influence of charge exchange collisions on a nucleon transfer reaction was studied. Transition rates of μ-capture reactions in ^{12}C were estimated, the shell-model structure of states in ^{50}Sc was calculated, and the deformation of levels in A = 14 nuclei was investigated. (auth)

7662 (RLO-1388-47) AN EXPERIMENTAL STUDY OF LOW ENERGY PROTONS FOLLOWING DEUTERON INDUCED REACTIONS: SPECTRAL FLUCTUATIONS AND DECAY FROM ISOBARIC ANALOGUE STATES. Cue, Nelson Wong (Washington Univ., Seattle). 1967. Contract AT(45-1)-1388. 220p. Dep. CFSTI. Thesis.

Low-energy protons (2.5 to 10 MeV) from deuteron-induced reactions on various targets were studied with the use of a ΔE-E detector telescope having a combined energy resolution of about 34 keV. In the first part of this work, the $Al^{27}(d,p)Al^{28}$ reaction leading to the continuum states was investigated in detail at deuteron energies around 16.5 MeV in an attempt to search for spectral fluctuations, i.e., fluctuations in the particle spectra corresponding to the continuum states in the residual nucleus. These fluctuations, in contrast to the conventional fluctuations in the excitation functions of reactions leading to a discrete final state, would be exhibited in a particle spectrum taken at a single bombarding energy. However, their observation requires a detection system resolution which is less than or roughly equal to the coherence width of the residual nucleus. Spectral fluctuations are predicted when the assumptions underlying the conventional fluctuation theory are extended to a situation of overlapping final states. Various correlation calculations were performed for the experimental proton spectra. The results indicated that the observed structure is not primarily attributable to spectral fluctuations, due to contributions from extraneous events corresponding to the secondary emission between discrete energy levels. Arguments are presented to show that these extraneous events are mainly from proton decay of the isobaric analogue states (IAS) formed in the ^{27}Al(d,n)^{28*}Si reaction. In the second part, the cross sections were measured for proton decay from isobaric analogue states ($T = T_z + 1$) formed in the (d,n) reactions on the following targets: ^{90,92,94}Zr, ^{92,94,98}Mo, ^{114,116,118,120}Sn, as well as ^{27}Al, ^{64}Ni, ^{68}Zn, ^{89}Y, ^{91}Zr, and ^{208}Pb. Excitation functions ($\theta_{lab} = 170°$) were obtained with the deuteron energies ranging from the (d,n) threshold of the ground state analogue (typically ~7 MeV) to 16 MeV. Angular distributions at various bombarding energies were also obtained for the stronger transitions. The cross sections are large only for the reactions leading back to the target ground state and when the neutron decay channels are closed to the IAS. Particular attention is paid to the large variation in the cross section for reactions which proceed through the analogues of $2d_{\frac{5}{2}}$, $3s_{\frac{1}{2}}$, and $2d_{\frac{3}{2}}$ states in the Zr, Mo, and Sn isotopes. At incident energies above several hundreds keV from the threshold, this variation is shown to be consistent with a sequential process in which the (d,n) formation mechanism is direct, when the decay through the spreading width is explicitly taken into account in the branching ratios. The overall energy dependence of the cross sections can be qualitatively understood if an additional mechanism such as a charge exchange process in the outgoing neutron channel of the (d,n) stripping reaction is considered. From the study of the ground state decay angular distributions of the $d_{\frac{5}{2}}$-IAS in Nb^{91*} and Tc^{93*}, it is shown that making strongly suggestive spin assignments to the IAS is sometimes feasible and that the extracted msubstate populations near threshold suggest the importance of spin-orbit interactions (or other spin dependent interactions) in the (d,n) formation mechanism. (auth)

7663 TIME-OF-FLIGHT MEASUREMENT OF PHOTONEUTRONS FROM ^{16}O, ^{40}Ca, AND ^{31}P. Mishina, Masanori (Tohoku Univ., Sendai); Tanaka, Eiji; Kageyama, Kosuke; Mutsuro, Naoshi; Asami, Akira; Kawarasaki, Yuuki; Nakajima, Yutaka. J. Phys. Soc. Jap., 23: 919-31(Nov. 1967).

Energy spectra of photoneutrons from ^{16}O, ^{40}Ca, and ^{31}P were measured by the time-of-flight method, using the JAERI (Japan Atomic Energy Research Institute) 20-MeV Electron Linac and its 50-meter neutron flight path. The flight time of the emitted neutrons was measured with a fast time-of-flight system. The energy range of measurement covered almost the whole region of the giant resonance for each sample. Many fine structure peaks in the energy spectra were observed. The results were compared with the photoreaction and inverse photoreaction cross sections measured by several other authors. The agreement was satisfactory. Theoretical calculations of the dipole states in ^{16}O and ^{40}Ca by Elliott and Flowers, and Brown et al., explain the gross features of the observed spectra but not the details. (auth)

7664 COMPLETE $(f_{\frac{7}{2}})^2$ SPECTRUM OF ^{42}Sc. Schwartz, J. J. (Univ. of Rochester, N. Y.); Cline, D.; Gove, H. E.; Sherr, R.; Bhatia, T. S.; Siemssen, R. H. Phys. Rev. Lett., 19: 1482-4(Dec. 25, 1967).

The $f_{\frac{7}{2}}$ states of ^{42}Sc were investigated using the reaction ^{42}Ca(^{3}He,t)^{42}Sc at incident ^{3}He ion energies of 12 and 26 MeV. Gamma spectra, triton spectra, and angular distributions for transitions to various levels were measured. A doublet consisting of 1498- and 1518-keV levels with probable spins of 3 and 5, respectively, was identified in ^{42}Sc. (D.C.W.)

7665 ANALYSIS OF THE ^{24}Mg(d,n)^{25}Al REACTION FROM 1.38 TO 2.8 MeV. Dietzsch, O. (Univ., Sao Paulo, Brazil); Willmore, D.; Hodgson, P. E. Nucl. Phys., A106: 527-44(1968).

Excitation functions and angular distributions for the neutron groups from the reaction ^{24}Mg(d,n)^{25}Al corresponding to the three lowest levels in ^{25}Al were measured using deuterons in the energy range 1.3 to 2.8 MeV and a neutron time-of-flight spectrometer. The data are analyzed using the optical model, the Hauser-Feshbach theory, and the distorted-wave Born approximation. (auth)

7666 A STUDY OF THE NUCLEAR STRUCTURE OF ^{60}Ni BY THE ^{59}Co(^{3}He,d)^{60}Ni AND ^{60}Ni(p,p')^{60}Ni REACTIONS. Barnard, R. W.; Jones, G. D. (Univ. of Colorado, Boulder). Contract AT(11-1)-535. Nucl. Phys., A106: 497-526(1968). (UCOL-535-569).

Angular distributions to the ground and 16 excited states of ^{60}Ni were measured for the ^{59}Co(^{3}He,d)^{60}Ni reaction at a bombarding energy of 37.7 MeV. The ^{59}Co(^{3}He,^{3}He)^{59}Co angular distribution was also obtained at the same energy. Discrete sets of optical potentials are found which give good fits to the elastic scattering data. It is found that DWBA calculations give better fits to the ^{59}Co(^{3}He,d)^{60}Ni data with a depth of the real part of the optical potential of U ≈ 170 MeV and $r_0 \approx 1.15$ fm, than with shallower potentials. It is also found that changes in optical model parameters obtained by fitting the elastic scattering data out to 90 or 150° have very little effect on DWBA fits to the ^{59}Co(^{3}He,d)^{60}Ni angular distributions. The angular distribution to the ground state of ^{60}Ni is characteristic of a proton transfer of $l_p = 3$ expected from the closing of the $1f_{\frac{5}{2}}$ proton shell. The next higher excited states show angular distributions with more than one l_p value contributing, indicating that the $(1f_{\frac{5}{2}})^{-1}$ $(2p_{\frac{3}{2}}, 2p_{\frac{1}{2}}$ or $1f_{\frac{5}{2}})$ proton particle-hole configurations are mixed. An analysis of ^{60}Ni(p,p')^{60}Ni data taken at 17.9 MeV at Berkeley by Jarvis et al., was carried out in an attempt to describe some of the inelastic proton angular distributions in terms of simple shell-model configurations. Shell-model form factors are used in distorted wave calculations, the requirement being that a particular particle-hole configuration satisfies both (^{3}He,d) and (p,p') data. It is noted that these configurations are still not without ambiguity. (auth)

7667 LEVEL STRUCTURE OF ^{49}V DEDUCED FROM ^{50}Cr(t,α) AND ^{48}Ti(^{3}He,d) REACTIONS. Bachner, D. (Max-Planck-Institut fuer Kernphysik, Heidelberg); Santo, R.; Duhm, H. H.; Bock, R.; Hinds, S. Nucl. Phys., A106: 577-90(1968).

The level scheme of ^{49}V was investigated using the ^{50}Cr(t,α) and ^{48}Ti(^{3}He,d) reactions. Angular distributions were measured, and spectroscopic factors were extracted by DWBA analysis. The data indicate particle-hole and configuration mixing in the proton states involved. The excitation of states of the $(f_{\frac{7}{2}})^3$ configuration is discussed in connection with possible target excitation processes. (auth)

7668 DETERMINATION OF THE PARITY OF THE 305-keV STATE OF ^{49}V BY LINEAR POLARIZATION CORRELATION MEASUREMENTS. Weigt, P.; Herzog, P.; Huebel, H.; Bodenstedt, E. (Univ., Bonn). Nucl. Phys., A106: 570-6(1968).

The linear polarization correlation of the (116-305) keV γγ cascade in the decay of ^{49}Cr was investigated by means of a multidetector apparatus. In two different runs, the polarization of the 305-keV radiation was measured as well as that of the 116-keV radiation. Positive parity was derived for the 305-keV state, and the measured coefficients confirm this result. The

measurements also give multipolarity assignments of the γ rays involved. (auth)

7669 FOUR-BODY CORRELATIONS IN LIGHT NUCLEI. I. FIRST EXCITED 0^+ STATES IN ^{16}O AND ^{40}Ca. Marumori, Toshio (Kyushu Univ., Fukuoka); Suzuki, Kenji. Nucl. Phys., A106: 610-40(1968).

A new theory of treating the four-particle–four-hole excitations (with the ground-state correlations) in light, closed-shell nuclei is proposed by using the basic idea of a "two-step method" proposed by Eichler and Marumori. In the theory, four-body scattering correlations are taken up in the first step as the most important correlations in light nuclei, and the corresponding four-body scattering eigenmodes are constructed in the framework of the new Tamm–Dancoff approximation. The interaction between these eigenmodes are treated as the next step. Thus the four-particle–four-hole excitations in light, closed-shell nuclei are described by "phonons" composed of a correlated pair of the four-particle scattering eigenmode and the four-hole one. Here in part I, properties of the four body scattering eigenmodes are investigated in detail, and a close connection between the four-body scattering correlations and the α-cluster is clarified. As a result of the theory, it can be shown that the first excited 0^+ states in ^{16}O and ^{40}Ca are mainly composed of the four-particle–four-hole excitations in the new Tamm–Dancoff sense. Essential ingredients to produce intrinsic deformations in the 0^+ states are discussed. (auth)

7670 THE $^{89}Y(p,n)^{89}Zr$ CROSS SECTION NEAR THE FIRST TWO ANALOGUE RESONANCES. Johnson, C. H. (Oak Ridge National Lab., Tenn.); Kernell, R. L.; Ramavataram, S. Contract W-7405-eng-26. Nucl. Phys., A107: 21-34(1968). (ORNL-P-3259).

The $^{89}Y(p,n)^{89}Zr$ cross section was measured for proton energies from 3.6 to 5.8 MeV. Threshold energies are given for the ground and first two excited states of ^{89}Zr. Proton optical model parameters are chosen in order to fit the average excitation function in terms of the Hauser–Feshbach theory. The resonance energies, level widths and maximum cross sections are given for the 2^- and 3^- analog state resonances. A detailed analysis of the 3^- resonance indicates that the existing theory of analog resonances is inadequate for obtaining quantitative agreement with experiment. (auth)

7671 CIRCULAR POLARIZATION OF NEUTRON-CAPTURE GAMMA RAYS FROM ^{65}Zn, ^{66}Zn, AND ^{57}Fe. Schaub, R.; Schuler, W. (Kernforschungszentrum Karlsruhe, Ger.). Nucl. Phys., A107: 14-20(1968).

The circular polarization of γ-rays following the capture of polarized thermal neutrons in targets of natural Zn and Fe was measured. For the 0.115 MeV level of ^{65}Zn, the spin $\frac{3}{2}$ was derived. For ^{66}Zn, a pure $J^\pi = 3^-$ capture state could be excluded. In the case of ^{57}Fe, the branching ratio of the 7.64 MeV γ-transition doublet to the ground state and the 14 keV excited state was redetermined and yielded $\beta = 1.43 \pm 0.23$. (auth)

7672 LACK OF EVIDENCE FOR SHELL EFFECTS IN THE (n,2n) CROSS SECTIONS. Hille, P. (Institut fuer Radiumforschung und Kernphysik, Vienna). Nucl. Phys., A107: 49-51(1968).

According to Bormann there exist strong neutron shell effects in the (n,2n) cross sections at 14 MeV neutron energy. There seems to be no contradiction to this statement in the literature up to now. Using the same experimental values for the cross sections as Bormann did, a strong dependence of the (n,2n) cross sections on the asymmetry factor (N–Z)/A is demonstrated, to which shell effects could represent only second-order corrections. While the quality of the experimental cross sections is too poor to exclude definitely small shell effects, there is certainly no clear evidence of any such effect. (auth)

7673 LEVELS OF ^{51}V AND ^{55}Mn VIA (n,n'γ) REACTIONS. Barrows, A. W.; Lamb, R. C.; Velkley, D.; McEllistrem, M. T. (Univ. of Kentucky, Lexington). Nucl. Phys., A107: 153-69(1968).

Differential cross sections for the production of gamma rays by inelastic neutron scattering in ^{51}V and ^{55}Mn were measured. Gamma-ray branching ratios for the subsequent decay of excited levels were also obtained. Measurements were made with pulsed-beam techniques for incident neutron energies from 1.0 to 3.1 MeV. Gamma-ray angular distributions and neutron inelastic scattering cross sections are compared with the predictions of the Hauser–Feshbach model. The comparison confirms spin assignments to excited levels of both nuclei. Those assigned are 0.320, $\frac{5}{2}$; 0.930, $\frac{3}{2}$; 1.609, $1\frac{1}{2}$; 1.813, $\frac{9}{2}$; 2.409, $(\frac{7}{2})$ in ^{51}V and 0.126, $\frac{7}{2}$; 0.983, $\frac{9}{2}$; 1.289, $1\frac{1}{2}$; 1.527, $\frac{3}{2}$; 1.884, $(\frac{5}{2}, \frac{7}{2})$ in ^{55}Mn. The first number of a pair indicates the excitation energy in MeV and the second the spin. Parentheses indicate tentative assignments. The branching ratios show that E2 transitions dominate in ^{51}V and M1 transitions dominate in ^{55}Mn. (auth)

7674 DETERMINATION OF THE ENERGIES OF SOME GAMMA TRANSITIONS. Legrand, J.; Boulanger, J. P.; Brethon, J. P. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Phys., A107: 177-80(1968). (In French).

The accurate determination of γ-transition energies using a Ge(Li) spectrometer is examined. The radionuclides studied and the results of the measurements (in keV) are ^{57}Co(122.09 ± 0.03 and 136.48 ± 0.08), ^{141}Ce(145.49 ± 0.03), ^{51}Cr(320.07 ± 0.07), ^{85}Sr(513.98 ± 0.03), ^{95}Zr(724.24 ± 0.06 and 756.87 ± 0.09), ^{95}Nb (765.84 ± 0.05), ^{54}Mn(834.78 ± 0.05), ^{88}Y(898.09 ± 0.05 and 1836.20 ± 0.08), ^{65}Zn(1115.41 ± 0.12) and ^{22}Na(1274.56 ± 0.09). (auth)

7675 A (p,γ) STUDY OF THE DECAY OF ISOSPIN ANALOGUE RESONANCES FROM 13 TO 16 MeV IN ^{89}Y. Shaforth, S. M. (Bartol Research Foundation, Swarthmore, Pa.); Legge, G. J. F. Nucl. Phys., A107: 181-92(1968).

Analog resonances in the reaction ^{88}Sr + p were observed in γ_0, p_0, p_1, p_2, p_3 exit channels simultaneously in the range $E_p = 5.85$ to 8.4 MeV, using 25–100 keV steps. Gamma-ray angular distributions were measured for the 6.10 and 7.51 MeV (lab) resonances. Radiative widths for the 6.10, 7.00–7.07 (unresolved) and 7.51 MeV resonances of 11 ± 4, 7 ± 3 and 14 ± 5 eV were deduced. These E1 decays are hindered with respect to single-particle transition rates by factors of 0.08, 0.03 and 0.05, respectively, even after taking into account the 2T + 1 isospin reduction. Factors which may contribute to such hindrances are discussed. An asymmetry in the (p,γ_0) yield curve for the 6.10 MeV s-wave resonance is thought to arise from interference with the giant dipole resonance. A $\frac{1}{2}^+$ assignment is made for the 7.51 MeV resonance and its analog, the 2.455 MeV level in ^{89}Sr. A strong resonance in the p_2 channel to the 3^- 2.74 MeV level in ^{88}Sr at $E_p = 7.92$ MeV which does not resonate in the entrance channel was found. (auth)

7676 DECAY OF ^{23}Ne. Moreh, R. (Israel Atomic Energy Commission, Negev); Balderman, J.; Gozez, Y. Nucl. Phys., A107: 236-40(1968).

The gamma radiation following the decay of ^{23}Ne produced by $^{22}Ne(n,\gamma)$ reaction was studied using Ge(Li) detectors. No indications were found for levels at 2.285, 2.405 and 2.870 MeV excitation reported by Lancman et al. (auth)

7677 PROPERTIES OF SEVERAL STATES IN ^{41}K NEAR 8.9 MeV. Bloch, R.; Pixley, R. E.; Winkler, H. (Univ., Zurich). Helv. Phys. Acta, 40: 832-44(Nov. 15, 1967).

Resonance anomalies were observed in protons elastically scattered from ^{40}Ar at three resonances near 1.1 MeV. Measurements at 90, 125 and 141° indicate that the 1086-, 1102- and 1108-keV resonances are formed by p-wave protons. The spin $\frac{1}{2}$ assignment could be excluded on the basis of alpha-particle and gamma-ray angular distributions indicating that all three resonances are $J^\pi = \frac{3}{2}^-$. A least squares fit was made to the elastic scattering data using the theoretical cross section folded with the measured resolution thereby determining Γ and Γ_p/Γ. The values of Γ, Γ_p/Γ, and Γ_α are 7.9 ± 1.9 eV, 0.49 ± 0.16, and 0.032 ± 0.012 eV for the 1086-keV resonance; 21.9 ± 2.5 eV, 0.58 ± 0.08, and 0.064 ± 0.024 eV for the 1102-keV resonance; and 5.1 ± 0.8 eV, 0.70 ± 0.15, and 0.019 ± 0.006 eV for the 1108-keV resonance. (auth)

7678 THE REACTION $^{23}Na(d,\alpha)^{21}Ne$ AT $E_d = 1.1$ MeV. Stanojevic, Dimitrije M. Bull. Boris Kidric Inst. Nucl. Sci., 17: 249-54(Oct. 1966).

The angular distributions of three alpha groups from the $^{23}Na(d,\alpha)^{21}Ne$ reaction were measured at $E_d = 1.1$ MeV. All three distributions show marked asymmetry around 90°. The experimental data were analyzed in terms of Legendre polynomials. The integrated cross sections are not consistent with the 2J + 1 law. (auth)

7679 DIFFRACTION GENERATION OF PARTICLES BY PROTONS FROM EMULSION NUCLEI IN A PULSED MAGNETIC FIELD. Zhdanov, G. B.; Tret'yakova, M. I.; Chernyavskii, M. M. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.), 6: 74-6(Aug. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 558-62(Aug. 1, 1967).

The diffraction production of particles on complex nuclei was investigated by exposing Ilford G-5 and K-5 emulsions to proton beams of 21 and 24 GeV/c in strong magnetic fields. 28 stars satisfying the conditions for the diffraction process were identified. It was found that for values of the total transverse momentum of the secondary particles ≤ 0.2 GeV/c, the phenomenon is accompanied by a slight background due to peripheral interactions with individual (quasi-free) nucleons of the nuclei. It was concluded that the resonant diffraction generation of two pions via a ρ meson can not readily be reconciled with experiment due to the relatively small values of the effective masses. (D.C.W.)

7680 AN INVESTIGATION OF EXCITED STATES IN ^{42}Ca BY THE BOMBARDMENT OF ^{41}K WITH 1860 TO 2170 keV PROTONS. Anttila, Asko (Univ. of Helsinki). Ann. Acad. Sci. Fenn., Ser. A VI, No. 247, 5-24(1967).

All the possibilities of decay of the resonance states in the ^{41}K + p reaction were studied in the energy region E_p = 1860 to 2170 keV. Alpha-particle, gamma-ray and neutron yields were observed simultaneously; and 84 resonances were tabulated. A more detailed investigation was made of the decay of the 1942-keV resonance by measuring α_0, γ_0, and n distribution, and by determining the resonance strength and the gamma-ray decay scheme. A spin assignment of 1$^-$ was arrived at for this resonance level, and the population and the formation parameters were also determined. The measured channel spin mixing ratio is not in agreement with the values of L–S, nor the j–j coupling scheme. Three other α_0 and one n distributions were also measured, and spin assignments of 1$^-$ or 2$^+$ were found at several resonances. (auth)

7681 INELASTIC SCATTERING OF 26 MeV DEUTERONS. Tjin A Djie, H. R. E.; Mulder, K.; Udo, F.; Groeneveld, A.; Koerts, L. A. Ch. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Phys., A106: 85-98(1968).

Angular distributions of the elastic and inelastic scattering of 26 MeV deuterons by Mg, Ca, Fe, ^{58}Ni, Zn, and Ce were measured and analyzed using the coupled-channels method. Values of the deformation parameter β are obtained for several excited states. (auth)

7682 BETA-GAMMA CIRCULAR POLARIZATION CORRELATION IN THE DECAY OF ^{48}V. van Nooijen, B. (Vanderbilt Univ., Nashville); Meulenberg, A. Jr.; Ramayya, A. V.; Hamilton, J. H.; Pinajian, J. J. Contract W-7405-eng-26. Nucl. Phys., A106: 129-37(1968). (ORNL-P-3199).

The β-γ circular polarization correlation of the (698 keV, 4$^+$ → 4$^+$, β^+)–(1.31 + 0.99 MeV, γ) cascade in ^{48}V was measured using the standard forward Compton scattering technique for the detection of the circular polarization of the gamma rays. The energy selection of the β-rays was performed with an anthracene crystal in one experiment and with a magnetic lens spectrometer in a second one. The use of the latter instrument has the following advantages: no scattering of electrons in air, negligible gamma-gamma coincidence background, improved energy selection of the beta rays and elimination of interfering 511 keV annihilation radiation in the β-detector in case of positon emitters. The measured asymmetry coefficient is A = 0.002 ± 0.035 for the first experiment and A = −0.005 ± 0.031 for the second. The average value A = −0.002 ± 0.024 gives for the isospin impurity coefficient and the effective Coulomb matrix element $(4.0 \pm 1.1) \times 10^{-3}$ and 28 ± 8 keV, respectively. (auth)

7683 ABSOLUTE EXPERIMENTAL AND THEORETICAL DETERMINATION OF THE ^{63}Cu(n,2n)^{62}Cu REACTION CROSS-SECTION. Cox, A. J.; Crumpton, D. (Univ. of Aston, Birmingham, Eng.). Nature (London), 216: 996(Dec. 9, 1967).

This cross section has been accepted as a standard for measuring neutron flux in the 14-MeV region, but its value varies rapidly with neutron energy, and it is important that it should be predictable on a theoretical basis in order to correlate experimental work. Such cross sections are usually calculated by a statistical model, using an experimental value for the relevant (n,n) cross section. In the method described the necessity of the measured (n,n) cross section has been eliminated. For an incident neutron energy of 14.7 MeV, the cross section is calculated to be 582mb, in good agreement with experimental measurements. The neutrons were obtained from the T(d,n)^{4}He reaction, using an incident deuteron energy of 140 keV, and the neutron yield was measured by the associated-particle technique. Copper disk samples were positively located close to the back of the tritium-titanium target and received neutrons emitted over a cone of solid angle 0.66 steradians. The induced activity of the samples was determined from the photopeak of the annihilation radiation, detected using a NaI(Tl) scintillation spectrometer. The theoretical variation of the cross section with neutron energy was also in close agreement with experimental results over the range 14 to 15 MeV. The calculation also proved capable of enabling prediction of the ^{65}Cu (n,2n)^{64}Cu cross section, which was computed to be 890 mb at 14.7 MeV, again in close agreement with the experimental value. (UK)

7684 ISOMER RATIOS FOR THE REACTIONS ^{88}Sr(p,pxn) AND ^{88}Sr(p,p3n). Sachdev, D. R.; Yaffe, L. (McGill Univ., Montreal). Can. J. Chem., 45: 2711-21(Nov. 1967).

Isomeric cross-section ratios for nuclides formed from (p,2n), (p,3n), (p,4n), and (p,p3n) reactions on ^{88}Sr are presented. The experimental results for the ^{88}Sr(p,2n)^{87}Y^{m,g} reaction are compared with statistical-model calculations in which spin-density parameter values were obtained from various theoretical formalisms. The parameters required to match the calculated and experimental values are in good agreement with those obtained by Vandenbosch et al. (auth) (CANADA)

7685 EVIDENCE FOR THE ISOBARIC SPLITTING OF THE GIANT RESONANCE FROM THE REACTION ^{89}Y(p,γ_0)^{90}Zr. Axel, P. (Univ. of Illinois, Urbana); Drake, D. M.; Whetstone, S.; Hanna, S. S. Phys. Rev. Lett., 19: 1343-4(Dec. 4, 1967).

A small but well-defined resonance was found in ^{90}Zr near the predicted $T_>$ component of the giant dipole resonance. (auth)

7686 γ-RAY ABSORPTION CROSS SECTIONS OF ^{19}F, ^{24}Mg, ^{27}Al, AND ^{40}Ca IN THE GIANT DIPOLE RESONANCE REGION. Nikolaev, F. A. pp 77-124 of Photodisintegration of Nuclei in the Giant Resonance Region. Skobel'tsyn, D. V. (ed.). New York, Consultants Bureau, 1967.

An investigation of the photoabsorption cross sections of the doubly magic nucleus ^{40}Ca and of the strongly deformed nuclei ^{27}Al, ^{19}F, and ^{24}Mg is discussed in detail. Photon energies of 8 to 30 MeV were used. It was found that the cross sections have considerable structure, indicating the existence of individual levels or groups of closely spaced levels. It was also found the shell-model treatment of the photoabsorption cross section agrees only qualitatively with experimental data. The rms radii of charge distribution were determined for the nuclei. No clearly expressed separation of transitions resulting from deformation was observed in the absorption cross sections. 105 references. (D.C.W.)

7687 PHOTOPROTONS FROM MEDIUM WEIGHT NUCLEI ($50 \leq A \leq 125$) AND A MECHANISM FOR THE DECAY OF EXCITED NUCLEI IN THE GIANT DIPOLE RESONANCE REGION. Osokina, R. M. pp 125-91 of Photodisintegration of Nuclei in the Giant Resonance Region. Skobel'tsyn, D. V. (ed.). New York, Consultants Bureau, 1967.

An experimental investigation of the (γ,p) reaction on ^{121}Sb, ^{123}Sb, ^{114}Cd, ^{65}Cu, ^{58}Ni, ^{60}Ni, ^{64}Ni, ^{93}Nb, ^{116}Sn, ^{124}Sn, and Zn at bremsstrahlung endpoint energies from 18 to 29 MeV is discussed, following a review of previous investigations of photonuclear reactions in medium and heavy nuclei. Angular distributions and spectra of the photoprotons are presented, together with an interpretation of the data. 146 references. (D.C.W.)

7688 TOTAL REACTION CROSS SECTION AND ELASTIC SCATTERING OF 24.7 MeV ALPHA PARTICLES IN THE REGION OF A = 60 NUCLEI. Budzanowski, A.; Grotowski, K.; Kuzminski, J.; Niewodniczanski, H.; Strzalkowski, A.; Sykutowski, S.; Szmider, J.; Wolski, R. (Inst. of Nuclear Physics, Krakow. Jagellonian Univ., Krakow). Nucl. Phys., A106: 21-34(1968).

The total reaction cross section for the interaction of alpha particles of 24.7 MeV energy with Cr, Fe, Ni, Co, Cu, and Zn nuclei was measured by means of the transmission method. The corrections to the transmission measurements for the elastic scattering and for the charged products of reactions were determined from a specially performed experiment. The results for the total reaction cross sections are in agreement with the optical-model calculations. No minimum in the σ_R versus A curve for the nickel atomic mass number is observed. (auth)

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Refer also to abstracts 7436, 7569, 7629, 7661, 7674, 7679, 7687, 7748, 7752, 7762, and 7767.

7689 (BAW-316) ^{238}U NEUTRON CROSS-SECTION DATA FOR THE ENDF/B. Wittkopf, W. A.; Roy, D. H.; Livolsi, A. Z. (Babcock and Wilcox Co., Lynchburg, Va.). May 1967. 104p. Dep. CFSTI.

As part of the cooperative effort of the Cross Section Evaluation Working Group organized at Brookhaven National Laboratory in June 1966, the nuclear data on ^{238}U for use in the Evaluated Nuclear Data File B (ENDF/B) are presented. The data cover the energy range from 0.001 eV to 15 MeV. Data sources are referenced, and the theoretical methods used in evaluating certain data are described. A complete listing of the data in the ENDF/B format is provided. (auth)

7690 (JINR-E2-3551) ISOBARIC ANALOGUE RESONANCES IN NUCLEI OF CLOSED NEUTRON SHELLS. Beregi, P.; Lovas, I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 36p. Dep.

The scattering amplitude of the elastic proton scattering is investigated in the energy range of the isobaric analog resonances. The scattering amplitude is expressed as $f = f^{opt} + f^{res}$, where the background term f^{opt} is calculated by means of the standard optical

model, and the resonance term is derived using Feshbach's projection operator method. The "ideal" isobaric analog states (IAS) are introduced by applying the stepdown isospin operator T_- on the wave functions of the low-lying states of the target + neutron system. Afterwards the "target ground state + proton" component of the "ideal" IAS is projected out. Such a doorway-type state, the so-called "projected" IAS is assumed to play the role of the intermediate state of the scattering process. The method is applied for the calculation of the cross section and polarization of elastic proton scattering on ^{138}Ba, ^{140}Ce, and ^{142}Nd. The low-lying states of the target are calculated in the framework of the quasiparticle random phase approximation and the wave functions for the target + neutron system are obtained by diagonalizing the residual interaction in the quasiboson + single neutron basis. (auth)

7691 (JINR-E15-3573) FISSIONING ^{242mf}Am ISOMER FORMATION AT FAST NEUTRON RADIATIVE CAPTURE. Boka, I.; Martalogu, N.; Sezon, M.; Vylkov, I.; Vylkov, N.; Flerov, G. N.; Pleve, A. A.; Polikanov, S. M.; Tret'yakova, S. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1967. 7p. Dep.

The reaction ^{241}Am $(n,\gamma)^{242mf}$Am was studied at E_n = 0.2 to 7.2 MeV. The neutrons were obtained from the ^{7}Li(p,n)^{7}Be reaction. The excitation function has a peak in the energy region E_n = 0.2 to 3.0 MeV. The increase of the isomer yield with the further energy increase is connected with some impurity of "soft" neutrons in the spectrum. (auth)

7692 (JINR-P3-3564) NEITRONNYE REZONANSY IZOTOPOV NEODIMA. (Neutron Resonances of Neodymium Isotopes). Karzhavina, E. N.; Nguyen Nguyen Phong; Popov, A. B.; Taskaev, A. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1967. 23p. (In Russian). Dep.

On a neutron spectrometer, measurements were performed of transmission and yields of γ ray from the neutron capture for the natural neodymium samples and for those enriched by ^{142}Nd, ^{143}Nd, ^{144}Nd, ^{145}Nd, ^{146}Nd, ^{148}Nd, and ^{150}Nd isotopes. The ^{143}Nd and ^{145}Nd isotopes were studied in the energy region up to 100 eV, while the other isotopes were studied in the region up to 10 keV. The following values of distance between the levels D: 1000 ± 250, 38 ± 6, 520 ± 70, 20 ± 3, 310 ± 43, 200 ± 21, and 230 ± 28 are obtained for the isotopes ^{142}Nd, ^{143}Nd, ^{144}Nd, ^{145}Nd, ^{146}Nd, ^{148}Nd, and ^{150}Nd, respectively, as well as the values of strength function S_0: $0.6 \pm 0.3 \times 10^{-4}$; $4.3 \pm 1.4 \times 10^{-4}$; $4.8 \pm 2.0 \times 10^{-4}$; $3.0 \pm 0.7 \times 10^{-4}$; $4.5 \pm 1.9 \times 10^{-4}$; $3.6 \pm 1.1 \times 10^{-4}$; and $2.0 \pm 0.8 \times 10^{-4}$. (auth)

7693 (NAA-SR-12500) MEASUREMENTS OF THE RESONANCE INTEGRAL AND DOPPLER EFFECT IN ^{186}W. Beller, L. S.; Latham, D. W.; Otter, J. M. (Atomics International, Canoga Park, Calif.). Oct. 16, 1967. Contract AT(04-3)-701. 48p. Dep. CFSTI.

Measurements of the resonance integral at infinite dilution, the effective resonance integral for finite sample sizes covering a range of a decade and a half in surface-mass ratio (S/M), and the Doppler effect as a function of S/M and temperature in the isotope ^{186}W are presented. The measurements were performed by activation of the ^{186}W component of natural tungsten in a nominally 1/E neutron energy spectrum. Both bare and cadmium covered measurements were performed. The integral values were obtained by comparing the measured cadmium ratio to that of gold. The measurements yielded a value of 450 ± 36 barns above an assumed cadmium cutoff of 0.7810 eV for the resonance integral at infinite dilution. This is in good agreement with previous cadmium covered measurements. The effective resonance integrals for finite sample sizes appear to be somewhat lower than those obtained by others who used enriched ^{186}W. The Doppler effect measurements yielded values that are in strong disagreement with calculations using any of the presently proposed parameters for the first resonance in ^{186}W. Not only is the magnitude of the effect different from that calculated, but the shape of the curve of the Doppler effect vs S/M was not reproduced by calculation. The observed temperature dependence of the Doppler effect is also strongly different from that calculated for this isotope and from those calculated and observed for analogous conditions in other isotopes. It is concluded that interference effects are present. The most likely cause is an incoherent overlap of the first resonance in ^{186}W by a nearby resonance in the ^{113}Cd used to filter out thermal neutrons. Other possible causes are related to overlaps and interferences by the other isotopes of natural tungsten. (auth)

7694 (NYO-2028-2, pp 1-11) MEASUREMENT OF THE g_R FACTORS FOR THE FIRST EXCITED STATES OF ^{174}Yb AND ^{176}Yb, USING THE MOESSBAUER EFFECT. Eck, J. S.; Lee, Y. K.; Walker, J. C. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics). (NYO-2028-16).

Using the Mössbauer effect following Coulomb excitation, the magnetic hyperfine interaction energies of the first excited states of ^{174}Yb and ^{176}Yb were measured. Metallic targets of Yb were used in conjunction with $YbCl_3 \cdot 6H_2O$ absorbers. Using the known value of the internal field in the absorber, the rotational gyromagnetic ratios for these states were determined to be $g_R^{174} = 0.338 \pm 0.015$, and $g_R^{176} = 0.381 \pm 0.018$. Within the accuracy of the experiment, no isomer shift was detected in either case. The theoretical predictions, based on the collective model with pairing interaction, are used to interpret the present results and existing Mössbauer data on other isotopes of Yb. A better agreement can be obtained between the current theoretical and experimental values of the gyromagnetic ratios and moments of inertia of the even-even Yb isotopes if the energy gap parameter used in the theoretical calculations is lowered by approximately ten percent. (auth)

7695 (NYO-2028-2, pp 12-17) OBSERVATION OF THE MOESSBAUER EFFECT IN ^{238}U FOLLOWING COULOMB EXCITATION. Oleson, J. R.; Lee, Y. K.; Walker, J. C.; Wiggins, J. W. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics).

Experiments performed on uranium show that the Moessbauer effect can be observed following Coulomb excitation of an actinide. There is evidence of structure in the observed spectra which may be due to quadrupole hyperfine splitting. (auth)

7696 (NYO-2028-2, pp 18-23) THE MOESSBAUER EFFECT IN ^{170}Er FOLLOWING COULOMB EXCITATION. Wiggins, J. W.; Lee, Y. K.; Walker, J. C. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics).

The Moessbauer effect in ^{170}Er was observed following Coulomb excitation. A suitable material for the target was found which emits an unsplit gamma spectrum. The 2Γ full width half maximum of the absorption line is 1.0 cm/sec without corrections for finite target and absorber thicknesses. Plans to measure the nuclear moments are discussed. (auth)

7697 (NYO-2028-2, pp 24-36) MOESSBAUER EFFECT IN ^{153}Eu. Shnidman, R.; Lee, Y. K. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics).

A Moessbauer effect in the 83-keV state of ^{153}Eu was observed. This level was populated by Coulomb excitation using 3-MeV protons on an enriched Eu_2O_3 target, and a symmetric unsplit line was observed using an Eu_2O_3 absorber. It is planned to perform an experiment to detect an isomer shift (IS) in this level. On the basis of conventional radioactive source experiments, it was concluded that for the IS experiment an EuB_6 absorber should be employed. (auth)

7698 (NYO-2028-2, pp 37-44) MOESSBAUER EFFECT FOLLOWING COULOMB EXCITATION OF ^{154}Sm. Pfeffer, R. A.; Eck, J. S.; Lee, Y. K.; Schnidman, R.; Walker, J. C. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics).

Magnetic hyperfine splitting of the 82-keV state of samarium-154 is to be studied following the Coulomb excitation of an enriched samarium oxide target. The unsplit target and magnetically split enriched samarium trichloride absorber, each kept at approximately 12°K, should yield a five line spectrum. The energy splitting, coupled with the knowledge of the effective field at the nucleus, permits the direct calculation of the nuclear g-factor for the 2^+ state. (auth)

7699 (NYO-2028-2, pp 58-62) MOESSBAUER EFFECT OF THE 105-keV LEVEL OF ^{155}Gd. Gleason, T.; Hershkowitz, N. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics).

The Moessbauer effect was observed in the decay of the 105.3-keV level of ^{155}Gd. A Ge(Li) detector was used to resolve the 105.3-KeV transition in order to prevent the detection of the Moessbauer effect of the 86.5-keV transition. The spin assignments of the 86.5- and 105.3-keV levels of ^{155}Gd were considered on the basis of other investigations; and the magnetic and quadrupole moments were estimated assuming that the 105.3-keV level is the "pure" Nilsson state $(642)^5/_2$. (D.C.W.)

7700 (NYO-2028-2, pp 69-73) HYPERFINE STRUCTURE OF THE 74.6-keV LEVEL OF ^{161}Dy. Oleson, J. R.; Loh, E.; Gleason, T.; Hershkowitz, N. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics).

The magnetic moment of the 74.6-keV level of ^{161}Dy was redetermined, using the Mössbauer effect; a value for the previously unreported quadrupole moment of this state was obtained. (auth)

7701 (OULNS-67-10) EXCITATION FUNCTIONS FOR THE DEUTERON INDUCED REACTIONS. Otozai, K.; Kume, S.; Okamura, H.; Mito, A.; Nishi, T.; Fujiwara, I. (Osaka Univ. (Japan). Lab. of Nuclear Studies). [1966]. 18p. Dep.

Excitation functions for reactions induced by deuterons on ^{70}Ge,

^{96}Zr and ^{130}Te were measured with the activation method up to 14.1 MeV deuteron energy. Observed reactions are ^{70}Ge(d,p)^{71}Ge, ^{70}Ge(d,n)^{71}As, ^{70}Ge(d,2n)^{70}As, and ^{70}Ge(d,α)^{68}Ga; ^{96}Zr(d,p)^{97}Zr, ^{96}Zr(d,n)^{97}Nb, ^{96}Zr(d,2n)^{96}Nb and ^{96}Zr(d,3n)^{95}Nb; and ^{130}Te(d,p)^{131}Te, ^{130}Te(d,n)^{131}I and ^{130}Te(d,2n)^{130}I. The results were explained with the modified Peaslee's theory presented previously for ^{142}Ce. Excitation functions on ^{96}Zr and ^{130}Te, together with ones on ^{142}Ce, give the common values of variable parameters, and the common pattern on relative contributions of n-stripping, p-stripping, and total absorption processes. The situations are quite different on ^{70}Ge. (auth)

7702 (PPAD-631D) NUCLEAR CHEMISTRY RESEARCH AT PRINCETON UNIVERSITY, 1966-1967. Annual Progress Report. Naumann, R. A.; Thomas, T. D. (Princeton Univ., N. J.). Aug. 30, 1967. Contract AT(30-1)-2137. 50p. Dep. CFSTI.

The energy levels of ^{192}Hg were investigated by measuring conversion-electron and γ spectra from the electron-capture decay of ^{192}Tl. The spallation of uranium by 3-GeV protons was also studied experimentally; α and γ spectra were measured using solid-state detectors. Gamma spectra from the decays of ^{135}Ce, ^{140}Cs, ^{142}Cs, ^{132}La, ^{134}La, ^{137}Xe, ^{138}Xe, ^{139}Xe, ^{140}Xe, ^{141}Xe, and ^{142}Xe were also measured; information on the energy levels of ^{132}Ba, ^{134}Ba, ^{140}Ba, and ^{142}Ba was obtained. Additionally, angular correlations, energy spectra, and yields of charged particles from the spontaneous fission of ^{252}Cf were measured. The effects of magnetic and axially symmetric quadrupole electric fields on the energy levels of ^{57}Fe were investigated as part of an investigation of the use of the Moessbauer effect for determining magnetic field direction in solids. A system for detecting single ions in an electromagnetic isotope separator was also designed. (D.C.W.)

7703 (ORNL-tr-1831) DIRECT INTERACTION DEUTERONS, TRITONS AND HELIUM IONS EJECTED BY 156 MeV PROTONS FROM MEDIUM AND HEAVY NUCLEI. Dubost, H.; Gatty, B.; Lefort, M.; Peter, J.; Tarrago, X. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from J. Phys. (Paris), 28: 257-70(1967). 25p. Dep. CFSTI. JCL $2.60 fs, $0.98 mf.

A telescopic device made of four solid-state detectors was used in order to identify deuterons, tritons, and helium ions and to measure their energy when they are ejected from Ag and Au targets bombarded by 156-MeV protons. Some results were also obtained at 90 MeV. The multidimensional analysis of dE/dx and E data was made with an electronic computer. The angular distribution has shown that, besides the isotropic process attributed to the "evaporation" mechanism, direct-interaction events were observed in the forward direction. The ^{4}He emission can be explained quantitatively by the so called "knock-out" mechanism in which prompt cascade nucleons enter in collision with α substructures. Deuterons, tritons, and ^{3}He are believed to be attributed to indirect pick-up processes which occur between prompt cascade nucleons and neutrons on the nucleus surface. (auth)

7704 (ORO-tr-3346-15) INVESTIGATION OF THE SPONTANEOUSLY FISSIONABLE PRODUCT ($T_{\frac{1}{2}}$ = 1.4 MINUTES) IN THE ^{230}Th + ^{10}B REACTION. Kuznetsov, V. I.; Skobelev, N. K. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by A. Lovett and J. H. Carter (Georgia Inst. of Tech., Atlanta), from report JINR-P7-2984. 4p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

A spontaneously fissionable product with a half-life of $T_{\frac{1}{2}}$ = 1.4 ± 0.25 min was observed by irradiating a ^{230}Th target with ^{10}B ions in the energy range 75 to 95 MeV. It is assumed that the evaporation reaction ^{230}Th(^{10}B,8n) ^{232}Am occurs. Two possibilities exist for the 1.4 min half-life observed: (1) the ^{232}Am nucleus undergoes spontaneous decay from its isomeric states with a 1.4 min half-life, or (2) the ^{232}Am nucleus undergoes orbital electron capture with a half-life of 1.4 min, a process that is possible if one proceeds from the expected electron-capture decay energy. Fission of the daughter ^{232}Pu from its excited levels, near the top of the fission barrier, may then take place. (S.F.L.)

7705 PRODUCTION OF ISOMERS BY (n,n') REACTIONS AND APPLICATION IN FLUX DENSITY MEASUREMENTS IN REACTORS. Koehler, W.; Knopf, K. (Technische Hochschule, Munich). Nukleonik, 10: 181-9(1967).

Metastable isomers of stable isotopes may be formed in nuclear reactors by inelastic neutron scattering. As these reactions could prove useful for measuring fast neutron flux densities, the average (n,n') cross sections were determined for the energy distribution of neutrons with energies greater than 0.1 MeV at the surface of a light water-moderated reactor for the following isotopes to: ^{103}Rh, 247 ± 30 mb; ^{77}Se, 392 ± 18 mb; ^{115}In, 109 ± 9 mb; ^{87}Sr, 55 ± 3 mb; ^{111}Cd, 173 ± 10 mb; ^{197}Au, 270 ± 40 mb; ^{137}Ba, 113 ± 6 mb; ^{89}Y, 68 ± 9 mb; ^{190}Os, 2.34 ± 0.12 mb; and ^{204}Pb, 9.2 ± 0.4 mb. The measured cross sections were compared with the values calculated from the differential flux density and the differential cross sections. In most cases there is a good agreement between the two values. The usefulness of two (n,n') reactions was shown by determining flux densities between 0.1 and 3 MeV in two low-temperature irradiation facilities and in one position at a distance of 35 cm from the surface of the reactor core, by a simple but straightforward procedure. The value φ (0.1 MeV) obtained by this three-group method agrees for the in-core position quite well with the value obtained from the calculation by normalization to the flux density measured by high-energy threshold detectors. In the two other positions, the shape is very similar to that of the calculations by French and Eggen. (auth)

7706 COMPILATION AND COMPUTATION OF DATA ON THE NUCLEAR PROPERTIES OF ^{235}U FISSION PRODUCTS. Iyer, M. Ramakrishna; Ganguly, A. K. (Atomic Energy Establishment, Trombay, India). pp 460-76 of Proceedinnnnngs of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14-18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

The fission of ^{235}U results in the formation of a large number of radioactive nuclides ranging from mass number 72 to 161. About 315 nuclides, both stable and unstable, have been identified among the products of thermal-neutron-induced fission of ^{235}U. For 22 of these fission products, no experimental information is available on their gamma decay energies, but their half-lives and fission yields are known. These are mostly short-lived nuclides. A procedure similar to the one adopted by Perkins and King (Nucl. Sci. and Eng., 3: 726-45(1958)) is employed to estimate the gamma decay energies and gamma spectra in these cases. (S.F.L.)

7707 91 keV TRANSITIONS IN THE DECAY OF ^{147}Nd. Rajput, M. S. (Aligarh Muslim Univ., India). pp 448-58 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14-18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

Coincidence measurements were made on the 91 keV γ rays in the decay of ^{147}Nd. The existence of a 182 keV level was established by comparing the experimental value of the detection efficiency with the value given in the literature for the standard geometry. It is found that there are two 91-keV γ rays in cascade and the abundance of the β group feeding the level at 182 keV is 10 ± 1%. (S.F.L.)

7708 RESONANCE PARAMETERS FOR ^{233}U. Musgrove, A. R. deL. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Aust. J. Phys., 20: 617-23(Dec. 1967).

Single-level and multilevel resonance parameters are given for ^{233}U below 11 eV. The total and fission cross sections were fitted simultaneously and good agreement was obtained. Spin assignments determined by the least squares method support the prediction of the channel theory of fission that ^{233}U has two level populations: one with predominantly large fission widths and the other with much narrower widths. (auth)

7709 TEST OF M1-E2 MIXING IN THE DECAY OF $2^{+\prime}$ BETA VIBRATIONAL STATES. Hamilton, J. H.; Ramayya, A. V.; Whitlock, L. C.; Meulenberg, A. (Vanderbilt Univ., Nashville). Phys. Rev. Lett., 19: 1484-7(Dec. 25, 1967).

The 683-123 keV, $2^{+\prime} \rightarrow 2^+ \rightarrow 0^+$ γ-γ directional correlation in ^{154}Gd was measured in search of an M1 admixture. A liquid source of ^{154}Eu was used, and the γ-γ directional correlation was measured using a fixed 15-cm^3 Ge(Li) detector and an NaI(Tl) detector which was rotated through a cycle of 90, 135, and 180°. It was concluded that the 692-keV transition is essentially pure E2. (D.C.W.)

7710 ISOTOPIC SHIFT IN THE HAFNIUM SPECTRUM: DEFORMATIONS OF HAFNIUM, ERBIUM, AND DYSPROSIUM NUCLEI. Golovin, A. F.; Kramer, I. F. Opt. Spectrosc. (USSR) (Engl. Transl.), 23: 105-7(Aug. 1967).

Translated from Opt. Spektrosk., 23: 195-9(Aug. 1967).

The isotopic shifts of twenty of the spectral lines of hafnium were measured using enriched isotopes. The relative shift is $\Delta\nu$ (180-178) : $\Delta\nu$ (178-176) : $\Delta\nu$ (176-174) = 1.00 : (0.847 ± 0.007) : (0.887 ± 0.012). The isotopic shifts in the dysprosium spectrum are defined more accurately. The deformation parameters, the internal quadrupole moments, and the total probabilities of electric quadrupole transitions from the ground to the first excited state of the nucleus for the rare isotopes ^{174}Hf, ^{162}Er, ^{158}Dy, and ^{156}Dy are calculated from the measured relative shifts. (auth)

7711 CONTRIBUTION TO THE STUDY OF THE LEVEL SCHEMES OF THE EVEN–EVEN TELLURIUM ISOTOPES OF MASS NUMBER 118, 120, 122, 124, AND 126. Lagrange, J.-M.; Albouy, G.; Marcus, L.; Pautrat, M.; Sergolle, H.; Rahmouni, O. (Facultes des Sciences de Paris, Orsay, France). Ann. Phys. (Paris), 2: 141-53(May-June 1967). (In French).

The energy levels of ^{118}Te, ^{120}Te, ^{122}Te, ^{124}Te, and ^{126}Te were investigated by measuring the gamma spectra from the decays of ^{118}I, ^{120}I, ^{122}Sb, ^{122}I, ^{124}Sb, and ^{126}I. Ge(Li) and NaI(Tl) detectors were used; both singles and coincidence spectra were obtained. Gamma energies and intensities were determined as were half-lives. Decay schemes are proposed for ^{118}I, ^{120g,m}I, ^{122}Sb, ^{122}I, ^{124}Sb, and ^{126}I. (D.C.W.)

7712 DETERMINATION OF THE MOMENTS OF INERTIA AND DEFORMATIONS STARTING WITH MEASUREMENTS OF SHORT HALF-LIVES IN EVEN–EVEN DEFORMED NUCLEI. Abou-Leila, Hussein (Faculte des Sciences, Orsay, France). Ann. Phys. (Paris), 2: 181-95(May-June 1967). (In French).

In a systematic study of half-lives of the first excited states in even-even nuclei in the range $150 \leq A \leq 192$, the half-lives of the first 2^+ states of ^{172}Hf, ^{174}Hf, ^{176}Hf, ^{156}Dy, ^{158}Dy, and ^{152}Gd were measured. The reduced transition probabilities $B(E2, 2^+ \rightarrow 0^+)$, the intrinsic quadrupole moments Q_0, the nuclear deformation parameters β, the moments of inertia of a rigid body I_{rig} and the irrotational moments of inertia I_{irrot} are deduced and are discussed as a function of neutron number N. A new empirical relation relating the moments of inertia of nuclei with the deformation is found. A time-to-amplitude converter system covering mean lives from 10^{-8} to $2\text{-}3\text{-}10^{-11}$ sec is described. (auth)

7713 SYSTEMATICS OF E2 TRANSITIONS IN EVEN–EVEN DEFORMED NUCLEI. Rajput, M. S.; Sehgal, M. L. (Aligarh Muslim Univ., India). J. Phys. Soc. Jap., 23: 916-18(Nov. 1967).

Experimental data on the half-life measurements of the first 2^+ excited state in even-even deformed nuclei were compiled. A well-defined gradual decrease in the value of the ratio of the theoretical half-life to the experimentally measured half-life is observed with the increase in the value of the nonaxiality parameter γ_0 of Davydov and Filipov theory, which determines the deviations of the shape of the nucleus from axial symmetry. (auth)

7714 THE AVERAGE β ACTIVITY OF THE TOTAL FISSION PRODUCTS AS A FUNCTION OF TIME AFTER THERMAL FISSION OF ^{233}U, ^{235}U AND ^{239}Pu. Seyfarth, H. (Technische Hochschule, Munich). Nukleonik, 10: No. 4, 193-202(1967). (In German).

The buildup of the mean beta activity of fission products from fission of ^{233}U, ^{235}U, and ^{239}Pu was measured during irradiation in a constant current of thermal neutrons. The mean beta-decay rate per fission as a function of time after fission is obtained by differentiating the beta activity divided by the constant fission product rate. The measurements cover the time interval from 10^{-2} sec to 10 hours. The total number of beta decays per thermal fission of ^{233}U, ^{235}U, and ^{239}Pu was found to be 5.33 ± 0.2, 5.98 ± 0.2, and 5.57 ± 0.2, respectively, compared to the theoretical values of 5.27, 6.10, and 5.60, respectively. With 4π-counting only those conversion electrons and γ rays are recorded which are not coincident within the deadtime of the proportional counter with a beta particle. Measuring the coincident K x rays, the number of recorded conversion electrons per thermal fission of ^{235}U was found to be less than 5.4×10^{-2} during 1 hour after fission and less than 8.1×10^{-2} during 10 hours after fission. The prompt x ray spectrum from the primary ^{238}U fission products was measured. The number of prompt K x-ray quanta per thermal neutron fission of ^{235}U amounts to 0.31 ± 0.08. (auth)

7715 LEVEL STRUCTURE OF ^{238}U OBSERVED BY A STUDY OF THE ALPHA DECAY OF ^{239}Pu. Cline, J. E. (Idaho Nuclear Corp., Idaho Falls). Nucl. Phys., A106: 481-96(1968).

The decay of ^{239}Pu (2.4×10^4 y) to levels in ^{235}U was studied using the techniques of semiconductor detector spectrometry. A source of 99.83% enriched ^{239}Pu was used in these measurements. Over 90 transitions were identified as being associated with the decay of this nuclide, and approximately 75 of these were placed in a consistent decay scheme containing 28 energy levels. Rotational parameters were obtained for the five rotational bands identified in this work. Arguments are presented for specific Nilsson assignments to the band heads of the two $5/2^+$ rotational bands. (auth)

7716 COLLECTIVE 0^- VIBRATIONS IN EVEN SPHERICAL NUCLEI WITH TENSOR FORCES. Blomqvist, J. (NORDITA, Copenhagen); Molinari, A. Nucl. Phys., A106: 545-69(1968).

The $J^\pi = 0^-$ states of the eight nuclei ^{16}O, ^{40}Ca, ^{48}Ca, ^{56}Ni, ^{90}Zr, ^{114}Sn, ^{140}Ce and ^{208}Pb are computed in the framework of the particle-hole model with the Tamm–Dancoff and random phase approximations. The interaction used is similar to the effective interaction derived by Kuo and Brown and contains central, tensor and spin-orbit components. Coherent $\tau = 0$ and $\tau = 1$ states are obtained and the tensor force is found to give considerable attraction in the $\tau = 0$ modes. However, it is not strong enough to cause a transition to a state with single-particle orbits of mixed parity. (auth)

7717 DECAY OF 13.5 h ^{109g}Pd TO LEVELS OF ^{109}Ag. Graeffe, G. (Massachusetts Inst. of Tech., Cambridge. Inst. of Tech., Otaniemi, Finland); Gordon, G. E. Contract AT(30-1)-905. Nucl. Phys., A107: 67-80(1968). (MIT-905-103).

The β- and γ-decay of the 13.5 h ^{109g}Pd to levels of ^{109}Ag has been studied with the use of Ge(Li) detectors, NaI(Tl) crystals and coincidence equipment. The energies (in keV) and relative intensities of γ-rays observed are: 45(3.6), 88(8900), 104(2.2), 135(3.2), 146 (2.7), 311(100), 391(2.5), 413.5(26), 415.2(23), 425(1.8), 448(2.6), 551(1.5), 558(6.2), 602(21.5), 636(27), 647(65), 702(9.2), 707(4.5), 737(5) and 782(33). Excited states in ^{109}Ag were observed at 88 (41 sec ^{109m}Ag), 133, 311, 415.2, 702, 724, 736, 840, 863 and 870 keV. Spin and parity assignments for most of the levels were made on the bases of log ft values and γ-ray branching ratios along with data on Coulomb excitation from previous workers. The levels at 0, 311, 415.2, 702 and 863 keV have negative parity and have previously been observed in Coulomb excitation studies. The positive-parity levels at 133 keV has high spin and is apparently the $g_{9/2}$ single-quasi-particle level. The negative-parity levels of the odd-mass silver isotopes are understandable in terms of phonons coupled with the $p_{1/2}$ single-quasi-particle. However, properties of the positive-parity levels, particularly the low-lying $7/2^+$ level are not well explained by current nuclear models. (auth)

7718 (γ,xn) REACTIONS IN ^{121}I. Jonsson, G. G.; Forkman, B. (Univ. of Lund, Sweden). Nucl. Phys., A107: 52-66(1968).

The yields of the reactions (γ,n), (γ,3n), (γ,4n), (γ,6n) and (γ,7n) in ^{127}I were measured by activation analysis from their thresholds up to 830 MeV. The cross sections and the integrated cross sections were calculated. The experimental result has been compared with different sum rules. The (γ,n) cross-section found above the photomeson threshold is higher than expected from simple estimates of the nucleon and pion transparencies in the iodine nucleus. (auth)

7719 THE PARITY OF EXCITED I = 0 STATES IN ^{144}Nd AND ^{178}Hf. Huebel, H.; Kesternich, W.; Weigt, P.; Bodenstedt, E. (Univ., Bonn). Nucl. Phys., A107: 106-16(1968).

The spin of the 2.86 MeV state in ^{144}Nd was determined as I = 0 by a γ-γ directional correlation measurement. Positive parity was established for this level as well as for the three I = 0 states in ^{178}Hf by γ-γ linear polarization correlation measurements. (auth)

7720 NUCLEAR STATES OF ^{143}Pr. Megli, D. G.; Potnis, V. R.; Mandeville, C. E. (Kansas State Univ., Manhattan). Nucl. Phys., A107: 117-28(1968).

The energies and relative intensities of 21 gamma rays, emitted in decay of ^{143}Ce were measured in detectors of Ge(Li). Gamma-gamma coincidence experiments were performed, and beta-gamma coincidence studies were carried out. Calculation of values of log ft of eight beta spectra shows them to lie in the region of first forbiddenness. Eight excited nuclear energy states were established in ^{143}Pr at 57, 351, 491, 722, 937, 1061, 1158, and 1382 keV. Possible spin values were assigned to all these states. These excited states all have even parity. (auth)

7721 TRANSITIONS IN ^{133}Cs FROM THE DECAY OF ^{133}Ba. Notea, A.; Gurfinkel, Y. (Soreq Nuclear Research Centre, Yavne, Israel). Nucl. Phys., A107: 193-208(1968).

Gamma-ray transitions following the decay of ^{133}Ba to ^{133}Cs were investigated with a calibrated Ge(Li) detector. The K-electron internal conversion coefficients were found from the relative gamma intensities used in conjunction with published K-conversion electron intensities. Internal conversion coefficients were calculated from the internal conversion ratios. The measured energies of the gamma rays in keV and the absolute intensities in gammas per 100 disintegrations are $53.4_2 \pm 0.25$ ($1.9_6 \pm 0.22$), $81.1_5 \pm 0.26$ ($33._4 \pm 5.0$), $160.5_5 \pm 0.27$ ($0.62_6 \pm 0.074$), $223.2_1 \pm 0.45$ ($0.41_6 \pm 0.051$), $276.5_5 \pm 0.32$ ($6.0_1 \pm 0.67$), $303.0_5 \pm 0.63$ ($15.3_9 \pm 0.17$), $356.3_2 \pm 0.48$ ($51._7 \pm 5.7$) and $384.1_5 \pm 0.42$ ($7.3_4 \pm 0.82$). Electron capture branching ratios and log ft values leading to the 437, 384, 161, and 81 keV levels of ^{133}Cs are $0.71_6 \pm 0.086$ ($6.35^{+0.06}_{-0.05}$), $0.22_0 \pm 0.024$ (7.71 ± 0.05), $0.005_8 \pm 0.0070$ ($10.0^{+\infty}_{-0.4}$) and $0.05_8 \pm 0.11$ ($9.3^{+\infty}_{-1.9}$). Branching ratios of transitions and experimental gamma-decay transition probabilities are given. The results are compared with theoretical estimates from the single-proton model. Retardation and enhancement factors calculated from the results are discussed. (auth)

7722 NUCLEAR ENERGY STATES OF ^{171}Tm. Megli, D. G.; Agin, G. P.; Potnis, V. R.; Mandeville, C. E. (Kansas State Univ., Manhattan). Nucl. Phys., A107: 217-24(1968).

The half-life of ^{171}Er, decaying by beta emission to ^{171}Tm, was measured to be 7.8 ± 0.2 h. Utilizing Ge(Li) detectors, the gamma-ray spectrum of ^{171}Er was observed to contain 34 full energy peaks, four of them being interpreted to correspond to the presence of four unresolved gamma-ray doublets. The relative intensities of both the well-resolved quanta and the doublets were measured. Good evidence was obtained for the existence of excited states in the residual nucleus, ^{171}Tm, at 5, 117, 129, 425, 489, 637, 676, 737, 861, 913, 1000, 1226, and 1400 keV. Additional levels were tentatively proposed at 966 and 1171 keV. The results of this paper, combined with those of earlier investigations, have been employed to provide spin values and parities for the energy states. Nilsson numbers were assigned to some levels, and rotational characteristics to others. (auth)

7723 ACTINIDE FINGERPRINTS. Wapstra, A. H. (Inst. for Nuclear Physics Research, Amsterdam). Actinides Rev., 1: No. 1, 39-53(Sept. 1967).

Tables and charts are presented in which known data are conveniently arranged for rapid identification of actinide nuclides from their nuclear radiations. (B.G.D.)

7724 TABLE OF α-EMITTING NUCLIDES ACCORDING TO α-ENERGY. Post, J. C. (Inst. for Nuclear Physics Research Amsterdam). Actinides Rev., 1: No. 1, 55-69(Sept. 1967).

A table of α-emitting nuclides arranged according to α energy is presented as an aid in the interpretation of α spectra for analytical purposes. The table includes the energy Eα of the emitted α particle, relative abundance of the α emission of energy Eα, element and mass number, half-life of the nuclide, branching fraction of α emission of the nuclide, and year and symbol of first author of publication with a tabulation of author symbols given at the end of the table. (B.G.D.)

7725 STUDY OF COLLECTIVE LEVELS IN ^{116}Sn, ^{120}Sn, AND ^{124}Sn BY INELASTIC ELECTRON SCATTERING. Barreau, P.; Bellicard, J. B. (Centre d'Etudes Nucleaires, Saclay, France). Phys. Rev. Lett., 19: 1444-6(Dec. 18, 1967).

The inelastic scattering of 150-MeV electrons from tin-116, tin-120, and tin-124 was observed. The main 2^+ and 3^- states were studied. By comparison of the reduced transition probabilities $B_{exp}(L \rightarrow 0)$ with the corresponding single-particle estimates $B_1(L \rightarrow 0)$, the collective character of these levels, which changes appreciably from one isotope to another, was measured. (auth)

7726 HALF-LIFE OF HIGH-EXCITATION STATES OF ^{62}Ni, ^{114}Cd, AND ^{208}Pb. Begzhanov, R. B.; Islamov, A. A. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR, No. 3, 22-4(1967). (In Russian).

The nuclear resonance fluorescence of ^{62}Ni, ^{114}Cd, and ^{208}Pb was determined by means of a method for determining the radiative width of high energy nuclear states using γ rays from thermal neutron capture in iron. The γ-ray scattering at ~135° to the incident beam was recorded by NaI(Tl) crystal connected with a PEM-52 photoelectron multiplier and multichannel pulse analyzer. The crystal was shielded in front by 1 cm of Pb. The distance between the source-scatterer-detector was ~4 m. The data from all control experiments showed that all obtained signals were γ rays scattered by the iron source. (R.V.J.)

7727 THE DECAY OF 8 d ^{106m}Ag. Taylor, H. W.; Neff, N.; King, J. D. (Univ. of Toronto). Nucl. Phys., A106: 49-61(1968).

A total of 45 gamma rays associated with the decay of ^{106m}Ag was observed with a Ge(Li) spectrometer. The transitions which were not observed previously have the following energies: 1052.6, 1135.8, 1770.6 and 2244.9 keV. A level scheme for ^{106}Pd is proposed with improved level energies and a few amendments to some of the high-lying levels. All the observed transitions are incorporated into the scheme. (auth)

7728 STUDY OF ISOBARIC ANALOG RESONANCES IN ELASTIC SCATTERING OF POLARIZED PROTONS FROM ^{142}Nd. Clausnitzer, G. (Univ., Erlangen, Nuremberg); Fleischmann, R.; Graw, G.; Proetel, D.; Wurm, J. P. Nucl. Phys., A106: 99-103(1968).

Elastic scattering of polarized protons at the Erlangen 12 MeV Tandem accelerator from ^{142}Nd was used to assign spins to p-, f- and h-wave states in ^{143}Nd. The polarization data are in close agreement to a parametrized type of analysis applied to earlier cross section measurements. (auth)

7729 MEASUREMENT OF A SPIN 2 STATE IN ^{102}Ag AND THE DECAY OF ^{102}Ag. Greenebaum, B.; Jackson, A. D. Jr.; Naumann, R. A. (Princeton Univ., N. J.). Contract AT(30-1)-937. Nucl. Phys., A106: 193-8(1968). (PUC-937-273).

A spin 2 state was observed in ^{102}Ag by atomic beam magnetic resonance techniques. Energies and relative intensities of a number of gamma rays following the decay of ^{102}Ag were determined with a Ge(Li) detector. A search for conversion electrons from the isomeric transition in ^{102}Ag with a Si(Li) detector was not successful. (auth)

7730 INTERNAL CONVERSION M/L AND (N+O)/M RATIOS FOR E2 TRANSITIONS. Bogdanovic, M.; Mladjenovic, M.; Stepic, R. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Nucl. Phys., A106: 209-14(1968).

Internal conversion M/L ratios were measured for 12 transitions of the pure E2 type in nuclei with charge Z = 56 to 78 and in the energy interval of 80 to 600 keV. The results are in good agreement with recent theoretical values of Bhalla and Pauli. The measurement of (N + O)/M ratios showed that in calculating the total conversion coefficient the N + O shells can be accounted for using the relation $\alpha_{(N+O)} = 0.26\ \alpha_M$. (auth)

7731 LEVELS IN ^{134}Ba POPULATED BY THE DECAY OF ^{134}Cs. Abdul-Malek, A.; Naumann, R. A. (Princeton Univ., N. J.). Nucl. Phys., A106: 225-32(1968).

The energy levels in ^{134}Ba populated in the decay of ^{134}Cs were studied with the aid of a Ge(Li) detector and a six-gap orange spectrometer. Coincidence spectra were recorded using a NaI(Tl) spectrometer for gating and displaying the coincidence spectrum with a Ge(Li) spectrometer. The results support the existence of levels at 605, 1168, 1400, 1643 and 1970 keV. No evidence was found for levels previously suggested at 923, 1062, 1374, 1567, 1770 or 1845 keV. (auth)

7732 ISOBARIC ANALOGUE STATES OF ^{90}Zr IN THE EIGENCHANNEL THEORY. Piazza, A. (Univ., Frankfurt am Main); Wahsweiler, H. G.; Greiner, W. Phys. Lett., 25B: 579-84(Nov. 27, 1967).

Cross sections for the diverse photon-particle and particle-particle reactions leading to the ^{90}Ze 1^- compound system are calculated in the eigenchannel reaction theory. The isobaric spin impurity according to the so-called internal and external mixing is automatically included in this treatment. Two sharp resonances are obtained in the theoretical (γ,p_0) cross section which can be identified with known analogue states. (auth)

7733 PARTICLE CONFIGURATIONS IN ^{207}Pb. Darcey, W.; Jeans, A. F.; Jones, K. N. (Oxford Univ.). Phys. Lett., 25B: 599-601(Nov. 27, 1967).

A study of the reaction ^{206}Pb(d,p)^{207}Pb at bombarding energies of 8.0 and 18.7 MeV indicates that the 3.62- and 4.29-MeV states in ^{207}Pb are not the expected $11^+/2$, $15^-/2$ two-hole one-particle states. (auth)

7734 PRECISION THERMAL NEUTRON CROSS SECTION OF ^{167}Er BY MASS SPECTROMETRIC ASSAY. Su, Ching-shen. Troy, N. Y., Rensselaer Polytechnic Inst., 1966. 105p.

Thesis.

The thermal neutron cross section of ^{167}Er has been obtained by measuring the relative number of ^{168}Er atoms formed by radiative neutron capture, when very pure ^{167}Er samples were exposed to a highly thermalized neutron flux. A four-stage mass spectrometer was used to provide 10^6/l isotopic enrichments of ^{167}Er. It was also employed to measure the post-irradiation ^{168}Er/^{167}Er abundance ratios of the samples, which were placed in the D_2O moderated Argonne CP-5 reactor. The integrated neutron flux and effective neutron temperature in this reactor were also monitored mass spectrometrically, by observing isotopic ratio changes in nuclides whose cross section vs temperature characteristics are known. ^{149}Sm and ^{157}Gd were selected as the "non-1/v" absorbers that yielded this data. The effective neutron cross section of ^{167}Er was found to be 740 ± 21 barns at an effective neutron temperature of 42.8 ± 2.5°C and an integrated neutron flux of 3.37 ± 0.08 × 10^{19} neutrons/cm^2. The thermal neutron cross section of ^{167}Er was then calculated to be 669 ± 20 barns. (Disser. Abstr.)

7735 THE MEASUREMENT OF THE PHOTOFISSION CROSS SECTION OF ^{238}U USING MONOCHROMATIC PHOTONS. Oblock, Vencil Stanley. Madison, Wis., Univ. of Wisconsin, 1967. 134p.

Thesis.

The photofission cross section of ^{238}U was obtained in the energy region 5.1 to 9.716 MeV using the (n,γ) reaction if Cr, Ti, Ni, Co, Cu, and Fe as photon sources. These photons were collimated to a uranium foil (4.3 microns thickness) placed in front of a solid-state fission-fragment detector. The photon flux was measured with a 3 in. × 3 in. NaI right circular cylinder optically coupled to a photomultiplier tube. The photofission cross section was calculated from the measured fission rates and photon fluxes by expanding the photofission cross section in orthonormal polynomials of

energy. The calculated cross section did not resolve the resonances obtained by previous bremsstrahlung x-ray work in the energy range 6-8 MeV; furthermore, there was a distinct increase in the cross section in the energy range 8 to 9.716 MeV that would be indicative of a giant dipole resonance. The cross section obtained in this work averaged the resonances obtained by the x-ray work. Using the photon fluxes measured in this work and the cross section of the x-ray work depicting resonances, fission rates were calculated; they agreed with the measured fission rates within 13%. (Disser. Abstr.)

7736 TERNARY FISSION OF ^{238}U. Iyer, Ramaswamy Harihara. Lafayette, Ind., Purdue University, 1967. 174p. Thesis.

Data were obtained which tend to demonstrate clearly for the first time the existence of ternary fission in low-energy (compound) nuclear processes. Absolute cross sections for the formation of the light neutron-rich fission fragments ^{24}Na, ^{28}Mg, and ^{38}S which are far removed from the usual binary mass yield curve, were determined radiochemically in the 20- to 40-MeV ^{3}He- and ^{4}He-induced fission of ^{238}U. In addition, upper limits for the cross sections of ^{47}Ca and ^{212}Pb were obtained in the ^{4}He-induced fission of ^{238}U. Excitation functions for the formation of the ternary fission products ^{28}Mg, ^{38}S, (and ^{24}Na) were determined. The recoil properties of ^{28}Mg were studied. A range of ~12 mg/cm^2 in uranium and a most probable kinetic energy of 40 to 50 MeV were estimated for this ternary fission product. The total ^{3}He-induced binary fission excitation function of ^{238}U was also determined which revealed the interesting fact that the ^{3}He cross sections were considerably smaller than the ^{4}He cross sections at comparable excitation energies. (Disser. Abstr.)

7737 NUCLEAR SPECTROSCOPIC STUDIES OF SOME VERY HEAVY ODD-MASS NUCLIDES. Ahmad, Irshad. Berkeley, Calif., University of California, 1966. 133p. Thesis.

The nuclear radiations of nuclides: ^{233}U, ^{239}Pu, ^{243}Bk, ^{244}Bk, ^{245}Bk, ^{246}Bk, ^{249}Bk, ^{249}Cf, and ^{255}Fm were investigated with high-resolution spectrometers. The α-particle spectra of all nuclides except ^{249}Bk were measured with 6 mm diameter surface-barrier detectors. ^{249}Bk α-particles were analyzed with a double-focusing magnetic spectrograph. The γ-singles were examined with the recently developed Ge(Li) and Si(Li) detectors coupled with very-low noise "internal FET" preamplifiers. Weak alpha groups were observed in coincidence with γ-rays, detected with a NaI(Tl) scintillation spectrometer. To improve the overall coincidence efficiency a new coincidence apparatus was designed and built. This instrument consisted of a cooled 4.5 cm diameter semiconductor detector for α-particle detection and a 3 cm diameter by 2.7 cm long Ge(Li) detector for γ-ray analysis. The Ge(Li) detector could also be replaced with a NaI(Tl) detector. ^{249}Cf conversion electrons were measured with a cooled Si(Li) detector coupled with an internal FET preamplifier. On the basis of the work and previous information, energy-level diagrams of the daughter nuclei were constructed. The levels were grouped into rotational bands built on Nilsson single-particle states. Because of identification of several rotational members of the bands, definite Nilsson quantum number assignments have been made in most cases. The alpha intensity calculations of Poggenburg were found quite helpful in making these assignments. A strong Coriolis effect was observed in the ^{245}Am levels populated by the alpha groups of ^{249}Bk. Calculations were made with Nilsson wavefunctions, and these were found to agree with the experimental results. The Coriolis interaction was found important in almost all cases; the effect was very noticeable in the level spacings between the rotational members of the bands. High-lying bands in ^{245}Cm (at 644 keV) and ^{251}Cf (at 550 keV) were observed and 4 rotational members of each were identified. The modes of de-excitation of these levels indicate very small or no vibrational characters in them. This suggests that the vibrational bands, in this region lie at very high energies (~1 MeV) above the ground state. (Disser. Abstr.)

Nuclear Theory

Refer also to abstracts 6561, 7346, 7410, 7465, 7471, 7564, 7625, 7631, 7637, 7643, 7649, 7654, 7661, 7669, 7690, 7703, 7713, 7732, and 7733.

7738 (COO-1420-137) TABLES OF INTERNAL CONVERSION COEFFICIENTS AND PARTICLE PARAMETERS. Pauli, Hans-Christian (Basel Univ. (Switzerland). Purdue Univ., Lafayette, Ind.). Aug. 1967. Contract AT(11-1)-1420. 206p. Dep. CFSTI.

The internal conversion coefficients and particle parameters of the K and L subshells were recalculated for ten nuclei, i.e., Z = 60, 64, 68, 72, 76, 80, 84, 88, 92, and 96 and ten energies, i.e., k = 0.02, 0.05, 0.10, 0.15, 0.20, 0.30, 0.40, 0.50, 0.70, 1.00 m_ec^2. The four lowest orders of electric and magnetic multipole transitions were considered. The internal conversion coefficients and particle parameters of the M-subshells were computed for seven nuclei, i.e., Z = 72, 76, 80, 84, 88, 92, and 96 and for ten energies (see above). The screening of the atomic electrons was taken into account on the basis of the Thomas–Fermi–Dirac model. All static and dynamic effects of the finite nuclear size were taken into account, assuming a sharp nuclear edge. (auth)

7739 (ISS-67/9) FURTHER RESULTS OF THE MONTE-CARLO CALCULATION OF THE (e,e'p) REACTION FOR INCIDENT ENERGIES BETWEEN 300 AND 600 MeV. Farchi, G. (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Mar. 22, 1967. 43p. Dep.

The results of the report ISS 66/37, "Some Results of the Monte Carlo calculation of the (e,e'p) Reaction for Incident Energies between 300 and 600 MeV", are completed adding the values valid for a s-state with 70-MeV proton binding energy. Electron scattering angles and incident energies are kept the same as ISS 66/37. Ejected proton kinetic energies are still between 40 and 100 MeV. (auth)

7740 (JINR-E2-3543) SOLUTION OF THE t-MATRIX EQUATION IN CLOSED-SHELL NUCLEI. Blank, J. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 25p. Dep.

A method for solving the t-matrix equation in closed-shell nuclei using a spherical harmonic-oscillator representation is presented. The equation is transformed to an infinite algebraic system for the t-mattix elements, the exclusion operator being treated exactly. This system involves matrix elements of the general nucleon-nucleon potential (for hard-core potentials matrix elements of the regular part). The system can be solved with arbitrary accuracy which is given only by the chosen truncation. (auth)

7741 (JINR-P4-3584) SVERKHTEKUCHIE SVOISTVA YADER V OBLASTI 100 lt A lt 256. (Superfluid Nucleus Properties in the Region 100 lt A lt 256). Garistov, V. P.; Khristov, I. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 33p. (In Russian). Dep.

Pairing energies for spherical and deformed nuclei (in the region $100 < A < 256$) are calculated on the basis of superfluid nucleus model. The Nilsson scheme is chosen as one-particle equations of an average field. The pairing energies, calculated with the constants $G_N = 23\ A^{-1}$, $G_z = 27\ A^{-1}$ in the $150 < A < 256$ region and $G_N = 17\ A^{-1}$, $G_z = 20\ A^{-1}$ in the $100 < A < 150$ region, agree sufficiently well with the experimental data. The correlation functions and chemical potentials are obtained. The data obtained can be used for estimations of many physical processes in medium and heavy nuclei. (auth)

7742 (LYCEN-6752) ETUDE DE LA DIFFUSION ELASTIQUE DE PARTICULES DE SPIN 1/2 ET 1. APPLICATION AUX REACTIONS DE STRIPPING. (Study of Elastic Scattering of Particles of Spin 1/2 and 1. Application to Stripping Reactions). Audebert, Bernard (Lyon Univ. (France). Institut de Physique Nucleaire). July 1967. 87p. (In French). Dep. Thesis.

The elastic scattering of polarized beams of particles with spin $\frac{1}{2}$ and 1 is studied. The introduction of a spin-orbit coupling potential made it possible to obtain a better agreement with respect to the elastic scattering. In the case of spin 1, the agreement is not always perfect as the LS coupling cannot describe this phenomenon completely. Tensor potentials are then used. The optical model describes the elastic scattering well. The numerical application of these theories was made possible by the development of a program for a low-capacity computer. A DWBA calculation was made of the stripping reaction $^{28}Si(d,p)^{29}Si$. (J.S.R.)

7743 (NYO-2028-2, pp 106-20) MEASUREMENTS OF QUADRUPOLE COUPLING IN ATOMS BY REPOLARIZATION EFFECTS. Madansky, L.; Wells, John C. Jr. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics).

The effects of quadrupole coupling on the repolarization of nuclear spins in the presence of an external magnetic field were calculated. Although the general behavior of these phenomena follow the usual effects for cases of nuclear spin $\frac{1}{2}$, the effect of quadrupole coupling can change the magnetic field dependence quite markedly. It appears that observations of this sort can be used to measure nuclear quadrupole effects for radioactive nuclei where other techniques would not apply. (D.C.W.)

7744 (NYO-2028-2, pp 121-7) SURVEY OF BETA-EMITTING NUCLEI WITH HALF-LIVES LESS THAN TWO MINUTES. Wells, John C. Jr.; Pfeiffer, Loren; Williams, Robert L. Jr. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics).

A list of beta-emitting nuclei with short half-lives is presented as an aid in selecting nuclei that are suitable for recoil polarization measurements. The spins and parities of the states, the beta endpoint energies, the electron configurations for both the neutral and singly ionized atoms, and the nuclear magnetic moments are given. Information on nuclear reactions producing these nuclei is also included. (D.C.W.)

7745 ACTIVITY MEASUREMENTS IN GENETICALLY RELATED PAIRS OF RADIONUCLIDES. Rao, N. Jagannadha; Iyer, R. Krishnamoorthy; Parthasarathy, R. (Atomic Energy Establishment, Trombay, India). pp 502-14 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

The total activity of a system of radionuclides represented by $A \rightarrow B \rightarrow C$ will depend on the relative concentrations of A and B. To correlate activity measurements, independent of the relative amounts of A and B, the activity must be specified in terms of the parent or an activity proportional to that of the parent. It is shown that equilibrium activity can be calculated from two activity measurements and that it is more convenient to use equilibrium activity rather than the parent activity alone. The precision of such measurements is evaluated and methods for minimizing the errors are suggested. (S.F.L.)

7746 SIMPLE METHOD FOR THE RESOLUTION OF COMPLEX DECAY CURVES IN RADIOCHEMICAL ANALYSIS. Rao, N. Jagannadha; Iyer, R. Krishamoorthy (Atomic Energy Establishment, Trombay, India). pp 515-23 of Proceedings of the All India Symposium on Radioactivity and Metrology of Radionuclides, Bombay, March 14–18, 1966. Bombay, Atomic Energy Establishment Trombay, 1966.

See CONF-660341.

A simple iterative method is described for estimating the activity of a given radionuclide in the presence of others. An advantage of the method over the normal extrapolation is that the extrapolation is not arbitrary. (S.F.L.)

7747 DOUBLE β DECAY AND NEUTRINO PROPERTIES. Lazarenko, V. R. Usp. Fiz. Nauk, 90: 601-22(Dec. 1966). (In Russian).

The first theory of β decay, formulated by Fermi, was based on the existence of the neutrino, postulated by Pauli. The second era of the development of our knowledge of this phenomenon started with Yang and Lee's discovery of the nonconservation of parity in weak interactions and was further advanced by Landau's studies. The present status of the theory has been best summarized in the papers of Primakoff and Rosen and Dell'Antonio and Fiorini. Of special interest is the neutrino-free double β decay which could be used as an irrefutable argument against the principle of the conservation of the lepton charge. This theory is based on the assumption that the rest mass of the neutrino is exactly zero and the parity is not conserved in weak interactions. In that case, the Dirac equation has two solutions. In all observed double β decay processes, the original daughter nuclei have an even–even configuration. In some cases, the single β decay is energetically possible but because of the large spin change, the double β decay $(A,Z) \rightarrow (Z, Z \pm 2)$ is much more probable. This is the situation of the $^{48}Ca - ^{48}Sc - ^{48}Ti$ chain, in which the $^{48}Ca - ^{48}Ti$ double decay occurs at a much higher rate than the energetically possible but sixfold-forbidden single β decay $^{48}Ca \rightarrow ^{48}Sc$. The fact that no neutrino-free variant of the double β decay could be discovered is a strong argument in favor of the existence of an antiparticle of the neutrino. (65 references). (TTT)

7748 INFLUENCE OF SPIN–ORBITAL SPLITTING ON THE DIPOLE RESONANCE STRUCTURE IN ATOMIC NUCLEI. Zhivopistsev, F. A.; Moskovkin, V. M.; Yudin, N. P. Vestn. Mosk. Univ., Ser. III Fiz. Astron., No. 1, 109-10(Jan.-Feb. 1967). (In Russian).

The dipole resonance width in magic nuclei was examined, starting from the shell structure of one-particle levels of nuclei, This width is determined by the decay probability of the level into a continuous spectrum. The spin-orbital interaction supplies the negative parity in the dipole resonance range. The ^{208}Pb nucleus was chosen to study the effect of particle-hole states on the dipole resonance, including additional levels in the 13- to 16-MeV region. Pair interactions and oscillator wave functions were used in the calculations. It was found that consideration of the spin-orbital splitting changes the distribution of dipole transitions on the particle-hole levels, decreasing the ratio of the main level, while the second maximum is split between neighboring levels. The double-peaked character of the curve of the γ absorption by ^{208}Pb could be satisfactorily explained by these calculations. (TTT)

7749 FOUR-BODY CORRELATIONS IN NUCLEAR MATTER. Lawson, P. A.; Sampanthar, S. (Univ. of Salford, Eng.). Nucl. Phys., A106: 669-77(1968).

Integral equations for the T-matrix and wave function for a system of four particles interacting via two-body forces are set up and are solved. In terms of these solutions, an expression for the binding energy of nuclear matter due to the simultaneous interaction of four nucleons to all orders of perturbation theory is given. Methods of evaluating the integrals occurring in the expression are discussed. (auth)

7750 INELASTIC SCATTERING OF SPIN-1/2 PARTICLES IN THE AUSTERN–BLAIR THEORY. Hahne, F. J. W. (Univ. of Cape Town, CSIR, Pretoria). Nucl. Phys., A106: 660-8(1968).

The inelastic scattering of strongly absorbed spin-$\frac{1}{2}$ particles by spin-0 targets is treated in the Austern–Blair theory for one-phonon excitations, suitably extended to include spin-orbit interactions. Closed formulas for the cross section and the polarization are derived in the angular region $\epsilon \ll \theta \ll \pi - \epsilon$, $\epsilon = L^2/l_0$ where L is the spin of the excited level and l_0 is the cut-off angular momentum. Comparison with the corresponding expressions for elastic scattering reveals that the Blair phase rule holds for both the cross section and the polarization. (auth)

7751 NEW APPROXIMATION FOR THE PAIRING PROBLEM IN NUCLEI. Zuker, A. P. (Oxford Univ.). Nucl. Phys., A106: 641-59(1968).

A linearized approximation for the pairing Hamiltonian suggested by a set of equations obeyed by the coefficients defining the exact solutions. The approximation leads to prescriptions for the calculation of the ground state and low-lying 0^+ excited states. The resulting equations can be treated numerically without great difficulty even for the case of many particles moving in a large number of nondegenerate orbits. For the case of two shells, the approximation is solved; and good agreement with the exact solutions is obtained. Some remarks are made about the degenerate problem, and a simple derivation for Clebsch–Gordan coefficients is proposed. (auth)

7752 EFFECT OF SPIN-QUADRUPOLE FORCE ON THE RATE OF β DECAY TO COLLECTIVE STATES OF EVEN DEFORMED NUCLEI. Kuliev, A. A.; Pyatov, N. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., A106: 689-96 (1968).

It is shown that an essential decrease of the rate of the allowed β decay to the excited 0^+ states as compared with that to the ground state may be due to the spin-quadrupole residual interactions. The latter may be also responsible for the appearance of the second 0^+ state below the energy gap. The numerical calculations are carried out, and the decay chains $^{162}Ho \rightarrow ^{162}Dy$, $^{164}Tm \rightarrow ^{164}Er$ and $^{178}Ta \rightarrow ^{178}Hf$ are analyzed. (auth)

7753 TWO-NUCLEON TRANSFER AND PAIRING PHASE TRANSITION. Broglia, R. A. (Univ., Copenhagen); Riedel, C.; Soerensen, B. Nucl. Phys., A107: 1-13(1968).

A system of n particles moving in two non-degenerate j-shells and interacting via the pairing force is amenable to an exact treatment. This model exhibits a phase transition, namely the one between normal and superconductive phases. The behavior of the cross section for the two-particle transfer reaction in the seniority zero channel is studied. Special attention is paid to the transition region. (auth)

7754 MODELISTIC AND REALISTIC INTERACTIONS IN THE p,sd, AND pf NUCLEAR SHELLS. Ley-Koo, E.; de Llano, M.; Quintanilla, J. (Univ., Mexico, Mexico City). Nucl. Phys., A107: 35-48(1968).

A simple interaction model (pairing + quadrupole-quadrupole, with Rosenfeld exchange, single-body spin-orbit and long-ranged tensor) is used to obtain excitation spectra, β-decay ft values, electromagnetic moments, and transition rates of A = 6, 18, and 42 nuclei. The resulting low-lying spectra and wave functions are compared to those obtained by other workers with hard-core "realistic" interactions and the overlaps are found to be quite high, justifying to that extent the use of simplified interaction models which via group theoretical formalisms are particularly useful in the many-valence-nucleon problem. (auth)

7755 GENERAL VARIATIONAL EQUATIONS FOR STATIONARY AND TIME-DEPENDENT STATES. Rowe, D. J. (Univ.,of Rochester, N. Y.). Contract AT(30-1)-875. Nucl. Phys., A107: 99-105(1968). (UR-875-217).

General variational equations are derived, for stationary and time-dependent states, which are valid for arbitrary variations and are not necessarily restricted to closed-shell nuclei. It is shown that the stationary state equations converge to excited as

well as ground-state solutions and may therefore be useful, already in lowest order, for finding excited Hartree-Fock solutions. The time-dependent equations, which relate to the theory of small vibrations, are shown to be identical to the general equations of motion for nuclear excitations. The relationship between time-dependent Hartree-Fock theory and the stability condition for a stationary Hartree-Fock solution is shown to be general. The possibility of an imaginary root and the occurrence of a phase transition are interpreted. (auth)

7756 DESCRIPTION OF THE NUCLEAR ROTATIONAL BANDS BY THE COLLECTIVE VARIABLE METHOD. Nadjakov, E. (Inst. of Physics, Sofia); Mikhailov, I. N. Nucl. Phys., A107: 92-8(1968).

The method of a collective variable canonically conjugated to the angular momentum operator is generalized to describe the energy spacings between all the states of the rotational band. Formulae giving the energy dependence on the angular momentum are obtained for a quantal model of a doubly even nucleus rotating in a plane. These formulae generalize the Inglis formula for the moment of inertia. (auth)

7757 QUASI-ELASTIC SCATTERING TO ISOBARIC ANALOGUE STATES. Frahn, W. E. (Univ. of Cape Town). Nucl. Phys., A107: 129-38(1968).

A closed formalism is presented for quasi-elastic charge exchange reactions of strongly absorbed particles including transitions to the ground and excited isobaric analog states in the residual nuclei. For the sake of clarity, a number of simplifying assumptions are made which however preserve the main characteristic features of the angular distributions. It is indicated how most of these restrictions can be relaxed. The resulting generalized formalism is suitable for quantitative analyses of experimental data which will be reported in a subsequent paper. (auth)

7758 CONSISTENCY OF THE LOW-ENERGY THREE-NUCLEON OBSERVABLES AND THE SEPARABLE INTERACTION MODEL. Phillips, A. C. (Univ. of Sussex, Eng.). Nucl. Phys., A107: 209-16(1968).

Recent experiments indicate that the doublet n-d scattering length is 0.1 fm rather than the 0.7 fm given by older data. Using a separable interaction model to represent the low-energy two-nucleon central and tensor forces, an attempt is made to establish which of these two experimental values is consistent with the experimental binding energy. A significant modification of the model is required if the new experimental scattering length is correct. This is not so if the old data are accepted. (auth)

7759 CORRECTIONS TO THE REORIENTATION EFFECT OF COULOMB EXCITATION IN DEFORMED DOUBLY EVEN NUCLEI. Greiner, B. (Technische Hochschule, Darmstadt, Ger.); Arenhoevel, H. Nucl. Phys., A107: 225-35(1968).

The reorientation of the lowest 2^+ rotational state is influenced by 5 to 12% in general, depending on the energy of the incident ion. The resulting corrections of the calculated quadrupole moments of excited nuclear states are due to both the giant resonances and the β- and γ-vibrations. The quadrupole moment of the γ-band cannot be determined by Coulomb excitation, because the contribution of the reorientation effect to the cross section cancels against the second-order contribution via the first rotational state. (auth)

7760 SHAPE OF THE ATOMIC NUCLEUS. Bes, D. R.; Szymanski, Z. (Univ. of Warsaw). Sci. Progr. (London), 55: 187-202(Summer 1967).

The distortion of atomic nuclei, i.e., the deviations of their shape from the spherical, is discussed; and various methods leading to the experimental determination of nuclear deformations are analyzed. An attempt is made to understand the origin and nature of deformation in terms of the present knowledge of nuclear structure theory. (auth) (UK)

7761 INTERFERENCE EFFECTS IN COLLISIONS OF COMPLEX NUCLEI. Dalidchik, F. I. (Inst. of Chemical Phys., Moscow). JETP Lett. (USSR) (Engl. Transl.), 6: 76-8(Aug. 1, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 6: 562-5(Aug. 1, 1967).

Interference effects in the collision or production of identical nuclei are investigated considering, as an example, the elastic subbarrier scattering of nuclei of a beam A by a target of nuclei B, which can be effectively represented as a bound system of a nuclear particle and a core A_2 that is identical to the beam nuclei. (D.C.W.)

7762 QUANTITATIVE STUDIES OF NUCLEAR STRUCTURE THROUGH ISOBARIC ANALOG RESONANCES. Zaidi, S. A. A.; Darmodjo, S. (Univ. of Texas, Austin). Phys. Rev. Lett., 19: 1446-9(Dec. 18, 1967).

A method for the quantitative extraction of spectroscopic factors is outlined and is applied to the low-lying states in ^{209}Pb. A single-particle potential that gives an adequate description of the low-lying states in ^{209}Pb is found, and the elastic proton widths of isobaric analog states in ^{209}Bi are obtained from experimental data. (D.C.W.)

7763 DISPLACEMENT OF CORRESPONDING ENERGY LEVELS IN MIRROR NUCLEI. Lebon, G. (Univ., Liege). Mem. Soc. Roy. Sci. Liege (8), 13: No. 4, 1-125(1966). (In French).

A comparative study is made of the energy spectra of mirror nuclei. The principal works relative to the problem of the displacement of corresponding levels in light mirror nuclei are analyzed. The emphasis is placed on their inadequacies, and the framework in which an attempt is made to solve the same problem is defined. A general perturbation method of the nuclear potential is developed that is based on the theory of resonances with complex energy, the S-matrix theory. The displacement of resonant states associated with the elastic scattering of a particle by the supposedly central force field of the scattering nucleus is calculated. The particular case in which the unperturbed state is critical is treated separately. The general problem of the perturbation of resonance levels in the case with N paths is then analyzed. The formal results obtained are applied to the calculation of the variation between the first excited levels in some light mirror nuclei (^{3}He–^{5}Li, ^{7}Li–^{7}Be, ^{9}Be–^{9}B, ^{13}C–^{13}N, and ^{17}O–^{17}F). (J.S.R.)

7764 METHOD TO MEASURE NEUTRINO-GAMMA ANGULAR CORRELATION IN MUON-CAPTURE. Grenacs, L.; Deutsch, J. P.; Lipnik, P.; Macq, P. C. (Univ., Louvain, Belguim). Nucl. Instrum. Methods, 58: 164-6(Jan. 1968).

The Doppler-broadening of the gamma-ray emitted by a bound-state excited in muon-capture in complex nuclei was considered. This Doppler-broadened gamma spectrum is illustrated for special cases assuming realistic neutrino-gamma directional correlations and taking into account the finite energy-resolution of the Ge(Li) detector. It appears that the observation of the Doppler-broadened de-excitation gamma-ray spectrum offers a practical method to measure the neutrino-gamma directional correlation in muon-capture reactions. (auth)

7765 ISOTOPIC EFFECT IN THE SPECTRA OF HEAVY ELEMENTS. Golovin, A. F.; Striganov, A. R. (Inst. of Physics of the Earth, Moscow. Inst. of Atomic Energy, Moscow). Usp. Fiz. Nauk, 93: 111-50(Sept. 1967). (In Russian).

A review is given of experimental investigations of isotopic effects in spectra of elements from strontium to curium. Extensive data are included on the available experimental data related to the isotopic shift and isotopic shift constants for all even–even isotopes. The present status of the theory of the isotopic effect is discussed. Isotopic shifts are calculated within the limits of the drop model for compressed and deformed nuclei and, also, on the basis of the finite Fermi system considering nuclear shell structure. The results obtained are discussed and compared with experimental data. 123 references are included. (R.V.J.)

7766 ON THE EFFECT OF MUTUAL SHIELDING OF RESONANCES OF DIFFERENT ISOTOPES. Pucker, Norbert (Univ., Graz). Acta Phys. Austr., 25: 260-5(1967).

The effect of overlapping of resonances of different isotopes is discussed on the basis of a series expansion, which is used several times in the literature. Correction factors are derived to take into account this effect. The derivation is done for resonances in the statistical region, but without restriction to isolated resonances. Also some known results are rederived and compared. (auth)

7767 PRECISE EXPERIMENTAL STUDY OF β SPECTRA. CONFIRMATION OF PROPOSED CORRECTIONS OF RETRODIFFUSION. Franeau, J.; Quivy, R. (Institut Interuniversitaire des Sciences Nucleaires, Mons, Belg.). J. Phys. (Paris), 28: 633-6-(Aug.–Sept. 1967). (In French).

A method of correcting the deformation of low-energy β spectra due to the backscattering from the source backing was investigated. The differential scattering coefficient was determined in terms of the energy and angle of incidence of the β particles for backing thicknesses of 15 to 560 $\mu g/cm^2$. An experimentally obtained spectrum was corrected by this method. For the spectrum of ^{204}Tl, the results were in good agreement with the previously proposed corrections. (D.C.W.)

7768 TRANSFER REACTIONS IN SCATTERING OF COMPLEX NUCLEI. Varma, S. (Univ. of Kansas, Lawrence). Contract AT(11-1)-1120. Nucl. Phys., A106: 233-40(1968). (COO-1120-64).

Nuclear reactions in which a particle or a cluster is transferred at energies well above the Coulomb barrier during the collisions

are described in an analytic way using the smooth cutoff diffraction model and an expression for the differential cross-section is obtained. The theoretical prediction is compared with a few representative experimental results. (auth)

7769 SU_6 AND SU_3 SELECTION RULES IN THE STRUCTURE OF d-s SHELL STATES. Vincent, C. M. (Univ. of Witwatersrand, Johannesburg). Nucl. Phys., A106: 199-208(1968).

Selection rules are derived for the matrix elements of central and spin-orbit interactions connecting states belonging to different irreducible representations of the orbital SU_6 and Elliott SU_3 groups. The operation of these selection rules is investigated in the structure of light d-s shell nuclei. It is suggested that the (60) component of the central interaction can be neglected. It is also a good approximation to neglect those admixtures to the main component of a state which are forbidden in first order. The approximations greatly reduce the size of the Hamiltonian matrix which must be diagonalized in a shell-model calculation. (auth)

7770 SHELL-MODEL CALCULATIONS ON $1f_{\frac{7}{2}}^n$ AND $1f_{\frac{7}{2}}^{n+1}1d_{\frac{3}{2}}^{-1}$ CONFIGURATIONS. Dieperink, A. E. L.; Brussaard, P. J. (Univ., Utrecht). Nucl. Phys., A106: 177-92(1968).

Shell-model calculations are performed to investigate the level schemes of nuclei in the region $40 \leq A \leq 48$. The configurations considered are $1f_{\frac{7}{2}}^n$ and $1f_{\frac{7}{2}}^{n+1}1d_{\frac{3}{2}}^{-1}$. The effective interaction is determined in a least-squares fitting procedure. The resulting wave functions are applied to calculate M2 retardation factors and log ft values. (auth)

7771 EFFECTIVE MASSES FOR NUCLEAR FISSION. Hasse, Rainer W.; Ebert, Rolf; Suessmann, Georg (Univ., Frankfurt am Main). Nucl. Phys., A106: 117-28(1968).

The kinetic part of the classical Hamiltonian, which describes both symmetric and asymmetric nuclear fission, is computed as a quadratic form in the time derivatives of parameters determining the (sharp) nuclear surface. The nucleus is treated as an irrotational, non-viscous, and incompressible fluid and the problem is solved without using the "Wheeler assumption." An appropriate three-parameter description of the nuclear surface is chosen, and effective masses with respect to these parameters are computed numerically. Some of the results can be compared with those obtained by other authors. (auth)

7772 WIGNER-ECKART THEOREM APPLIED TO SU_3 MATRIX ELEMENTS OF CENTRAL INTERACTIONS. Vincent, C. M. (Univ. of Witwatersrand, Johannesburg). Nucl. Phys., A106: 104-116(1968).

The Wigner-Eckart theorem is applied to give the general form of $(\lambda\mu)$ diagonal matrix elements of central interactions belonging to (22) of SU_3 in Elliott's projected $|\lambda\mu KLM\rangle$ scheme. The result involves three reduced matrix elements which depend on the details of the interaction. The Clebsch-Gordan coefficients are given in closed form for arbitrary $(\lambda\mu)$. The result is applied to ^{24}Mg, neglecting the spin-orbit interaction and all but the (22) part of the central interaction. A K = L = 4 level is predicted at 9.34 MeV. (auth)

7773 G-MATRIX INTERACTION IN THE NUCLEAR 1p SHELL. Goldhammer, Paul; Hill, J. Roger; Nachamkin, Jack (Univ. of Kansas, Lawrence). Contract AT(11-1)-1120. Nucl. Phys., A106: 62-84(1968). (COO-1120-67).

A G-matrix interaction applicable to nuclear states of the configuration $(1s)^4(1p)^{A-4}$ is obtained by fitting the position of energy levels in the 1p shell. In addition to a simple two-body potential the three-body vector force previously shown to arise from second-order effects of the tensor force is included. A total of 18 potential parameters is fitted to 34 low-lying energy levels to an rms deviation of 0.381 MeV. An additional twelve known levels are predicted to an rms deviation of 0.402 MeV. The only well established levels for which a reasonable fit is not obtained are the strong α-emitting states in ^8Be and ^{12}C. It is concluded that α-clustering makes a significant contribution to the energy of these α-decaying states. (auth)

7774 SU_3 REDUCTION OF INTERACTIONS IN THE d-s SHELL. Vincent, C. M. (Univ. of Witwatersrand, Johannesburg). Nucl. Phys., A106: 35-48(1968).

The matrix elements of a basic set of 10 d-s shell central interactions belonging to irreducible representations (00), (22), (44), and (60) of SU_3 are calculated. Several model interactions are analyzed in terms of this basic set. The (44) interaction produced the main effects of pairing. The (60) interaction is strikingly small for realistic interactions. Besides (00), (44), and (60) interactions there are five independent (22) interactions, which are expected to produce rotational spectra. Some applications of such SU_3 reductions are given. Knowledge of the (00) part of the interaction fixes the centroid energy of an SU_3 multiplet. The non-(00) part determines the splitting within a multiplet, and it is appropriate to compare the non-(00) parts of two interactions to estimate the similarity of the splitting they produce. (auth)

7775 LIFETIME PREDICTIONS FOR SUPER-HEAVY ELEMENTS. Pierce, T. E.; Blann, M. (Univ. of Rochester, N. Y.). Nucl. Phys., A106: 14-20(1968).

Lifetime extrapolations are presented for elements of Z = 104 to 115 based on the masses of Myers and Swiatecki. The latter mass values were calculated with the assumption of shell closures at Z = 114, N = 184. The extrapolation formulas of Viola and Seaborg were used for α and spontaneous fission lifetimes; the Moszkowski nomographs were used for EC and β lifetimes. Calculations were performed both with the shell stabilization predicted by the Myers-Swiatecki mass formula and with one half the predicted stabilization energy for each isotope. Since many isotopes of $Z \leq 115$ are predicted to have lifetimes of minutes or longer, it is concluded that proposed synthesis experiments stand a very good chance of success. (auth)

7776 ACCURATE DETERMINATION OF THE INTERNAL CONVERSION COEFFICIENTS OF CASCADE GAMMA RAYS. Sen, S. K.; Rizvi, S. I. H. (Univ. of Manitoba, Winnipeg). Nucl. Instrum. Methods, 57: 227-8(Dec. 1967).

A new approach was adopted to determine accurately the internal conversion coefficients of cascade transitions from angular correlation measurements. (auth)

7777 INFLUENCE OF THE PHYSICAL DECAY OF A RADIOACTIVE TRACER ON THE RESOLUTION OF A SYSTEM OF COMPARTMENTS. Emmons, H. (Johns Hopkins Univ., Baltimore). Int. J. Appl. Radiat. Isotop., 18: 859(Dec. 1967).

Perrault, Bazin, and Pages (Int. J. Appl. Radiat. Isotop., 18: 7(1967)) previously summarized certain mathematical techniques for solving systems of compartments in order to show under what conditions corrections can most simply be made for the physical decay of a radioactive tracer. A simplified approach for solving the vector differential equation $\vec{R}' = A\vec{R} + \vec{a}$, $\vec{a} \neq 0$, which was discussed in the summary, is outlined. (D.C.W.)

7778 USE OF COMPLEX POTENTIALS IN NUCLEAR PHYSICS. Austern, N. (Univ. of Pittsburgh). Ann. Phys. (N. Y.), 45: 113-31(1967).

Derivations of optical potentials are given for several simple, physically interesting reaction models to illustrate the content of more general derivations. The use of complex coupling potentials in direct-reaction calculations is seen to be natural. A time-dependent analysis is also given. (auth)

7779 LINKED-CLUSTER EXPANSION FOR THE DEUTERON OPTICAL POTENTIAL. Junkin, W. F.; Villars, F. (Massachusetts Inst. of Tech, Cambridge). Ann. Phys. (N. Y.), 45: 93-112(1967). (MIT-2098-338).

The Goldstone-Hugenholtz linked-cluster expansion for the transition amplitude is derived for elastic deuteron scattering reactions. From this expression, the deuteron optical potential is derived, and the relation between this potential and the single-nucleon optical potential is established. (auth)

7780 PROBLEM OF EXTERNAL MIXING IN ISOBARIC ANALOG RESONANCES. Mello, P. A. (Inst. for Advanced Study, Princeton, N. J.). Ann. Phys. (N. Y.), 45: 240-64(1967).

External mixing in isobaric analog resonances is studied within the framework of R-matrix theory in the many-channel case, and the general behavior of the enhancement of the $T_<$ states is discussed. The problem is also studied in the Kapur-Peierls formalism, which is found to be very convenient from a physical point of view, because it leads directly to a giant-resonance interpretation of the effects of external mixing. The distribution of the widths of the fine-structure resonances is obtained and is compared with the results of other formulations. (auth)

7781 J DEPENDENCE FOR l = 1 NUCLEON TRANSFER. Yntema, J. L.; Ohunma, H. (Argonne National Lab., Ill.). Phys. Rev. Lett., 19: 1341-3(Dec. 4, 1967).

The J dependence for l = 1 nucleon-transfer reactions at an incident-deuteron energy of 23 MeV is qualitatively reproduced by distorted-wave calculations. Considerably greater damping of contributions from the interior of the nucleus is required than previously thought necessary in (d,p) reactions. This may imply that the energy dependence of the real potential for protons is stronger than the dependence previously obtained for neutrons. (auth)

7782 UPPER BOUNDS FOR ELECTROMAGNETIC TRANSITION RATES. Hsu, L. S. (Univ. of Rochester, N. Y.). Phys. Lett., 25B: 588-92(Nov. 27, 1967).

A method is presented for calculating the maximum possible electromagnetic transition rate from a state with a given JT to another state with J'T' achievable by working in a given set of

shell-model configurations. Numerical examples are given for the case where one of the states has J = 0, T = 0 and for the case where only one kind of nucleon is active and one of the states has J = 0. (auth)

7783 DETERMINATION OF THE SIGNS OF SHELL-MODEL MATRIX ELEMENTS FROM TWO-NUCLEON-STRIPPING DATA. Hardy, J. C.; Towner, I. S. (Oxford Univ.). Phys. Lett., 25B: 577-9(Nov. 27, 1967).

By consideration of the $^{28}Si(t,p)^{30}Si$ reaction, the sign of the interaction matrix element $\langle d_{\frac{3}{2}}^2|V|s_{\frac{1}{2}}^2\rangle_{J=0}$ is determined to be negative, and the sign of $\langle d_{\frac{3}{2}}^2|V|s_{\frac{1}{2}}d_{\frac{3}{2}}\rangle_{J=2}$ to be positive. The method has quite general applications. (auth)

7784 PHOTODISINTEGRATION OF NUCLEI IN THE GIANT RESONANCE REGION. Skobel'tsyn, D. V. (ed.). The Lebedev Physics Institute Series. Volume 36. New York, Consultants Bureau, 1967. 198p.

Separate abstracts were prepared for the five papers included, which deal with many-body field theory; excited states of ^{19}F; the photoabsorption cross sections of ^{27}Al, ^{40}Ca, ^{12}C, ^{19}F, ^{24}Mg, and ^{16}O in the giant resonance region; and photoproton emission from $50 \leq A \leq 125$ nuclei. (D.C.W.)

For abstracts of individual papers see: 7654, 7655, 7686, 7687, and 7785.

7785 SOME PROBLEMS IN MANY-BODY FIELD THEORY. Vagradov, G. M. pp 1-7 of Photodisintegration of Nuclei in the Giant Resonance Region. Skobel'tsyn, D. V. (ed.). New York, Consultants Bureau, 1967.

A system of fermions interacting strongly at zero temperature is considered using the methods of field theory; it is assumed that the forces acting between particles are paired. In particular, the ground-state stability of a system of fermions between which there exists an interaction potential comprising a short-range repulsive part and a long-range attractive part is studied. (D.C.W.)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 6546, 6680, 6933, 7032, and 7983.

7786 (ACNP-67533) INITIAL TESTING OF THE LA CROSSE BOILING WATER REACTOR. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). [nd]. Contract AT(11-1)-850. 80p. Dep. CFSTI.

LA CROSSE BOILING-WATER REACTOR — design data for; approach-to-power testing of; shutdown margin for, measurement during loading of; power level determination for, use of foil irradiations for; neutron flux maps of, detailed
REACTIVITY — eigenvalue determination for LACBWR, comparison of calculated and measured; determination of LACBWR core excess, use of boric acid for
REACTOR FUEL ELEMENTS — loading of LACBWR, initial
REACTOR CONTROL ELEMENTS — calibration of LACBWR, initial
CRITICALITY STUDIES — testing of LACBWR
NEUTRONS — flux distributions in LACBWR, foil irradiations for determining
NEUTRON SOURCES — installation in LACBWR of antimony–beryllium
RADIATION MONITORING — LACBWR environmental
BORIC ACID — use for determining core excess reactivity in LACBWR (M.M.S.)

7787 (AERE-R-5309) THE DETERMINATION OF BURN-UP ON DFR/26-1 CARBIDE RIG. Fudge, A. J.; Foster, E.; Cox, R. G. (Atomic Energy Research Establishment, Harwell (England)). Dec. 1966. 26p. Dep. CFSTI.

Nine fuel element pins of 15% PuC/85% UC (fully enriched uranium) irradiated in the Dounreay Fast Reactor were examined for burnup by three chemical methods: isotopic analysis of the uranium and plutonium before and after irradiation, stable neodymium fission product measurement by isotope dilution mass spectrometry, and measurement of the fission-product cerium-144 and cesium-137. The heavy element analysis method gave results which were higher than those by the other methods. The results from the various neodymium isotopes were in close agreement with each other except for the neodymium-150, which was consistently higher than the others. On the whole the neodymium results were slightly lower than the results from the heavy element method. The radiochemical results from cerium-144 and cesium-137 were consistently and significantly lower than the neodymium results. The methods used are described and possible reasons for the differences obtained by the various methods are discussed. The precision of the burnup determination on this rig is considered to be ±15% (one sigma). (auth)

7788 (ANL-7382) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, SEPTEMBER 1967. (Argonne National Lab., Ill.). Oct. 31, 1967. Contract W-31-109-eng-38. 155p. Dep. CFSTI.

EXPERIMENTAL BREEDER REACTOR-II — operation history of, detailed; core for, power and isothermal temperature coefficients for; reactivity measurements in, effects of power level on; hydraulic and thermal studies for; sodium coolant for, chemical analyses of
REACTOR FUELS — reprocessing cycle for, operation of ANL; radiation effects testing of oxide-type; radiation effects on mixed carbide; radiation effects testing of high-temperature; thermodynamics of, mass-spectrometric studies for determination of
REACTOR FUEL ELEMENTS — temperature monitoring of EBR-2 subassemblies; chemical analyses of irradiated pin-type; failure detector for, plugging meter and sampler for; subassemblies of, design of instrumented; radiation effects testing of jacketed–metal fuel; cladding materials for, radiation effects on; cladding materials for, radiation effects on
REACTIVITY — measurements in EBR-2, effects of nuclear parameters on; measurements in sodium–plutonium core of ZPR-3 of perturbed; calculations for FTR core-reflector configurations, preliminary; effects caused by voiding AARR internal thermal column
REACTOR CONTROL ELEMENTS — remote handling of, development of equipment for
STAINLESS STEELS — mechanical properties of Type 304L, effects of exposure to sodium on
MATERIALS TESTING NONDESTRUCTIVE — fuel element damage analyses using; electromagnetic field diffusion for, development of pulsed
CRITICAL ASSEMBLIES — Doppler effect measurements in plutonium-fueled ZPR-3; reactor fuel elements for ZPR-3, foil-activation measurements of heterogeneity effects in; reactivity measurements in sodium–plutonium core of ZPR-3 perturbed; resonance interaction effects measurements in ZPR-9
SODIUM — purity of, development of methods for controlling and measuring; corrosive effects on reactor materials, effects of temperature on; heat transfer and two-phase flow characteristics of boiling; nucleate boiling in, effects of heat flux and pressure on; corrosion inhibition in liquid, use of dissolved getters for; flow of boiling, characteristics of two-phase
FLOWMETERS — magnetic materials for, thermal and mechanical tests on
REACTORS, LIQUID METAL–COOLED — core components for, test loop for
URANIUM ALLOYS, PLUTONIUM ALLOYS, ZIRCONIUM ALLOYS — Pu–U–Zr, radiation effects testing on reactor fuels of
URANIUM OXIDES UO_2 — radiation effects on, electron microprobe analysis of; physical properties of liquid
PLUTONIUM OXIDES PuO_2 — radiation effects on, electron microprobe analysis of
CHROMIUM ALLOYS — Cr–Ti–V–base, creep strength of, effects of annealing temperature on; Cr–Ti–V–base, thermal conductivity measurements on
TITANIUM ALLOYS — Cr–Ti–V–base, creep strength of, effects of annealing temperature on; Cr–Ti–V–base, thermal conductivity measurements on
VANADIUM ALLOYS — Cr–Ti–V–base, creep strength of, effects of annealing temperature on; Cr– Ti–V–base, thermal conductivity measurements on
MASS TRANSFER — measurements of nickel, effects of exposure to sodium on; facility for studies on high-temperature, description of; measurement in liquid sodium, effects of exposure time on nickel
FAST TEST REACTOR — core for, neutron cross section calculations averaged over; reactivity calculations for core-reflector configuration in, preliminary
NEUTRONS, FAST — detection of, continuous flow manganese bath system for
NEUTRONS — resonance integrals for, calculation of infinite-dilution
REACTORS, FAST — fuel elements for, development of analytical procedures for fission-product burnup monitors for
CORROSION — inhibition in liquid sodium, use of dissolved getters for
METALS — kinetics of systems of liquid, dissolution
URANIUM; PLUTONIUM — recovery from low enrichment fuels, use of fluoride volatility process for
REACTORS, MOLTEN SALT — salt-transport separation processes for, distribution coefficients for
FISSION PRODUCTS — removal from molten salt systems
SEALS AND GLANDS — mechanical testing of gaskets
REACTOR SHIELDING — gamma-heating rates in AARR biological, calculation of
REACTOR EXPERIMENTAL FACILITIES — voiding of AARR internal thermal column, calculated reactivity effects of partial
ALKALI METALS — physical properties of
TELLURIUM FLUORIDES — removal from fluoride volatility process streams
REACTOR CONTAINMENT STRUCTURES — response of finite circular cylindrical, calculation of dynamic elastic
PLUTONIUM CARBIDES, URANIUM CARBIDES — PuC–UC, radiation effects on fuels of
NICKEL ALLOYS — mass transfer in liquid sodium, measurement of
ARGONNE ADVANCED RESEARCH REACTOR — beam tube test facility for, description of; core structures for, thermal analysis of; shielding for, gamma-heating rates; reflector for, gamma-heating rate distribution in beryllium; shielding for, calculations for gamma heating rates in biological
TRANSDUCERS — development of fission-gas pressure; spectra calculated from transfer functions of
GAMMA RADIATION — heating rates from, calculations for AARR biological shielding; heating rate distribution in AARR beryllium reflector (M.L.S.)

7789 (APDA-CFE-14) COMPILATION OF CURRENT TECHNICAL EXPERIENCE AT ENRICO FERMI ATOMIC POWER PLANT. Monthly Report No. 14, September 1967. McCarthy,

J. F. (Atomic Power Development Associates, Inc., Detroit, Mich. Power Reactor Development Co., Detroit, Mich. Detroit Edison Co., Mich.). Nov. 1967. Contract AT(11-1)-865. 33p. Dep. CFSTI.

A summary of technical experience gained from the fuel meltdown in Fermi Fast Breeder is given. Methods of core inlet plenum inspection are discussed. The identification of the object and design and fabrication of a device for removing it from the inlet plenum are described. Sodium and gas systems analyses are given; special investigations are described. Predicted and measured performance is compared. Causes for real performance are discussed. (M.L.S.)

7790 (APDA-NTS-9) POWER COEFFICIENT MEASUREMENTS FOR THE ENRICO FERMI REACTOR. Enrico Fermi Atomic Power Plant Nuclear Test Series. Mueller, R. E.; Wilber, H. A. (Atomic Power Development Associates, Inc., Detroit, Mich.). Nov. 1967. 75p.

Power coefficient measurements were made by static physics measurements at four different times for increasing maximum power levels ranging from 13 to 100 MW(t) nominal power. Two of the measurements were made at two-thirds nominal core A flow and two at full core A flow. Measurements were made during both power ascent and power decent to investigate possible hysteresis effects. Results of the measurements at the four power ranges are presented. No hysteresis effect was observed in any of the measurements. The measured values indicate that the feedback reactivity is approximately 28% smaller than originally calculated, which is considered to be adequate agreement. The power coefficient data at different flows were analyzed to obtain an estimate of the flow coefficient. These results showed that only 4% of the feedback was flow-independent. (H.D.R.)

7791 (APDA-NTS-10) MEASUREMENT AND CALCULATION OF THE ^{235}U AND ^{238}U FISSION DISTRIBUTIONS AND ^{238}U CAPTURE DISTRIBUTIONS FOR THE ENRICO FERMI FAST BREEDER REACTOR. Enrico Fermi Atomic Power Plant Nuclear Test Series. Page, E. M.; Horne, R. E.; Beaudry, R. J.; Montfort, J. C. (Atomic Power Development Associates, Inc., Detroit, Mich.). Oct. 1967. 131p.

Experiments were conducted to determine ^{235}U and ^{238}U fission distributions and ^{238}U capture distributions in the core and blanket regions of the Enrico Fermi reactor by irradiating U foils in special core and radial blanket subassemblies. These special subassemblies were constructed from normal core and blanket subassemblies by replacing the central fuel pins with a stainless steel sheath. Foil tubes containing the desired U foils and stainless steel spacers were inserted in the steel sheaths. Loading (and unloading) of the foil tubes into the special subassemblies was performed in a glove box especially constructed for this purpose. The irradiated foils were counted with standard single channel scintillation counting equipment with fission product decay counting employed to establish fission distributions and ^{239}Np soft γ counting employed to establish ^{238}U capture distributions. The techniques provided relative reaction-rate distributions. Absolute reaction rates were determined for selected foil pairs by radiochemical techniques at Argonne National Laboratory. The measured distributions generally confirmed those obtained by multigroup techniques. Notable exceptions occurred mainly in soft spectrum regions far from the core; reasons for these exceptions are discussed and necessarily include an investigation of the sensitivity of the calculated results to various calculational parameters and techniques. (auth)

7792 (BNWL-477) REVIEW OF REACTOR SAFETY ANALYSES OF FAST AND LIQUID METAL COOLED REACTORS. Shaver, R. E.; Wittenbrock, N. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1967. Contract AT(45-1)-1830. 58p. Dep. CFSTI.

To gain a better understanding of the safety philosophies applied to the design of fast and liquid metal cooled reactors, the safety analysis reports of the following facilities were reviewed: Enrico Fermi Atomic Power Plant (FERMI), Hallam Nuclear Power Facility (HALLAM), Southwest Experimental Fast Oxide Reactor (SEFOR), Fast Reactor Test Facility (FARET), Experimental Breeder Reactor No. 1 (EBR-I), Experimental Breeder Reactor No. 2 (EBR-II), and Fast Reactor Zero Power Experiment (ZPR-III). Information is presented in tabular form under the following subdivisions: Control and Safety Systems, Reactor Protection Systems, Backup Systems, Containment or Confinement Systems, Inherent Reactivity Effects and Important Physics Parameters, Fuel and Fuel Handling, Accidents Considered and Chemical Problems, Site, Exhaust Ventilation System, and Waste Effluents. 11 references. (M.L.S.)

7793 (CVNA-297) SIX MONTH OPERATING REPORT, APRIL 1, 1967-SEPTEMBER 30, 1967. (Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. C.). Nov. 1967. Contract AT(30-1)-2289. 13p. Dep. CFSTI.

Final shutdown activities for CVTR are summarized. Containment and ventilation systems testing is discussed; offsite fuel element shipment is described. Plant radiation surveillance and monitoring is outlined. (M.L.S.)

7794 (DOCKET-50-275(Amend-1)) NUCLEAR PLANT DIABLO CANYON SITE FIRST SUPPLEMENT TO PRELIMINARY SAFETY ANALYSIS REPORT. Bonner, John F. (Pacific Gas and Electric Co., San Francisco, Calif.). [1967]. 130p. Dep. (U.S. only). CFSTI.

Amendment No. 1, Docket 50-275, Diablo Canyon Power Reactor is the first supplement to the preliminary hazards and safety analyses. It contains answers to AEC questions, a report concerning the strength criteria for piping and vessels to assure no failure under earthquake loading, and a design change adding eight additional part length control rods. (M.L.S.)

7795 (DOCKET-50-275(Amend-2)) NUCLEAR PLANT DIABLO CANYON SITE SECOND SUPPLEMENT TO PRELIMINARY SAFETY ANALYSIS REPORT. Bonner, John F. (Pacific Gas and Electric Co., San Francisco, Calif.). [1967]. 210p. Dep. (U.S. only). CFSTI.

Amendment No. 2, Docket 50-275, of the Preliminary Safety Analysis Report (PSAR) for the Diablo Canyon Power Reactor contains revisions of the original PSAR reflecting all updating of the chemical and volume control system and the sampling system. Answers to AEC questions are also detailed. (M.L.S.)

7796 (DOCKET-50-275(Amend-3)) NUCLEAR PLANT DIABLO CANYON SITE THIRD SUPPLEMENT TO PRELIMINARY SAFETY ANALYSIS REPORT. Bonner, John F. (Pacific Gas and Electric Co., San Francisco, Calif.). [1967]. 350p. Dep. (U.S. only). CFSTI.

Amendment 3, Docket 50-275, of the Preliminary Safety Analysis Report (PSAR) for Diablo Canyon Power Reactor contains material on: geology; design and analyses of engineered safety system, showing that operation of the safety injection system will prevent fuel cladding melting for double ended pipe failure; and a supplemental table of contents indicating the location of all answers to AEC questions. (M.L.S.)

7797 (DOCKET-50-275(Amend-4)) [DIABLO CANYON PRELIMINARY SAFETY ANALYSIS REPORT]. Bonner, John F. (Pacific Gas and Electric Co., San Francisco, Calif.). Sept. 8, 1967. 6p. Dep. (U.S. only). CFSTI.

Amendment No. 4, Docket 50-275, of Preliminary Safety Analysis Report (PSAR) for Diablo Canyon Power Reactor contains a composite listing of PSAR sections relating to design compliance with the DRL requirements for General Design Criteria as published in 32 Federal Register 10213. (M.L.S.)

7798 (DOCKET-50-275(Amend-5)) NUCLEAR PLANT DIABLO CANYON SITE FOURTH SUPPLEMENT TO PRELIMINARY SAFETY ANALYSIS REPORT. Sibley, S. L. (Pacific Gas and Electric Co., San Francisco, Calif.). [1967]. 190p. Dep. (U.S. only). CFSTI.

Amendment No. 5, Docket 50-275, of the Preliminary Safety Analysis Report for Diablo Canyon Power Reactor contains: seismologic considerations of the Diablo Canyon site; strength criteria ensuring no loss of function of piping and vessels under earthquake loading; and financial data, including Pacific Gas and Electric's 1966 Annual Report to its stockholders. (M.L.S.)

7799 (DOCKET-50-275(Amend-6)) NUCLEAR PLANT DIABLO CANYON SITE FIFTH SUPPLEMENT TO PRELIMINARY SAFETY ANALYSIS REPORT. Bonner, John F. (Pacific Gas and Electric Co., San Francisco, Calif.). [1967]. 205p. Dep. (U.S. only). CFSTI.

Amendment 7, Docket 50-275, of the Preliminary Safety Analysis Report for Diablo Canyon Power Reactor includes: the research and development programs appropriate for the Diablo Canyon plant and applicability of the ACRS report on the Vermont Yankee Nuclear Power Station to the Diablo Canyon plant; use of burnable poison rods in the Westinghouse pressurized water reactors; and experimental determination of the departure from nucleate boiling in large rod bundles at high pressures. (M.L.S.)

7800 (DOCKET-50-275(Amend-7)) NUCLEAR PLANT DIABLO CANYON SITE SIXTH SUPPLEMENT TO PRELIMINARY SAFETY ANALYSIS REPORT. Bonner, John F. (Pacific Gas and Electric Co., San Francisco, Calif.). [1967]. 55p. Dep. (U.S. only). CFSTI.

Amendment No. 7, Docket 50-275, of the Preliminary Safety Analysis Report for the Diablo Canyon Power Reactor contains design information on the instrumentation and controls system,

in addition to answers to AEC questions on emergency core cooling and control instrumentation. (M.L.S.)

7801 (EURAEC-1917) STABILITY TESTS ON BOILING WATER REACTORS. Special Report No. 1, January 1–December 31, 1966. Hoeld, Kraemer (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main (West Germany). Kernenergie-anlagen). Contract 085-66-1TEED. 59p. (EUR-3399). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

The results of the stationary measurements on the ring-gap geometry of the AEG instability test rig are presented as correlation curves of the "stationary local steam bubble component as a function of the local steam content" for various water inlet velocities and determined analytically by means of approximation curves. The measurement of the frequency response "heat output-local steam bubble component" covered three different heights along the measurement stretch with varying frequency, heat output, water inlet velocity, and inlet undercooling. (auth)

7802 (EURAEC-1923) SAXTON PLUTONIUM PROJECT. Quarterly Progress Letter for the Period Ending September 30, 1967. Miller, R. S. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Nov. 1967. Contract AT(30-1)-3385. 19p. Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

Destructive examination and performance evaluation of low-burnup Pu-enriched mixed oxide fuels, which were irradiated in Saxton Power Reactor is discussed. Fission gas release and radiochemical burnup data are evaluated. (M.L.S.)

7803 (EURFNR-421) THE SAFETY OF STEAM-COOLED FAST REACTORS AS INFLUENCED BY THE DESIGN AND ARRANGEMENT OF THEIR COMPONENTS. Erbacher, F.; Frisch, W.; Huebschmann, W.; Ritz, L.; Woite, G. (Kernforschungszentrum, Karlsruhe (West Germany)). Oct. 1967. 49p. (KFK-655; EUR-3688). Dep.

Work performed under United States–Euratom Fast Reactor Exchange Program.

Presented are reasons why the dynamic behavior and the safety of a steam cooled fast reactor is particularly dependent on the design and the arrangement of the cooling cycle and its components. It is pointed out that by a suitable design and arrangement a self-controlled system can be obtained and the consequences of certain major accidents greatly reduced. Independent of any specific reactor design, the criteria to achieve this are defined. (auth)

7804 (EURFNR-422) CENTRAL STATION FAST BREEDER REACTOR PLUTONIUM FUEL REQUIREMENTS. Kummerer, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material- und Festkoerperforschung). Oct. 1967. 14p. (KFK-661; EUR-3697; CONF-671005-5). Dep.

Work performed under United States–Euratom Fast Reactor Exchange Program.

From Nuclear Metallurgy Conference, Phoenix, Ariz.

Some basic decisions on fuel and pin type are introduced into the field of the principal criteria for the fuel of large fast breeder reactors, which are presently in a conceptual stage. These criteria comprise the questions of safety and economy and refer also to the applicable fabrication techniques. As the German development program pursues in parallel the two lines of a sodium cooled fast breeder and a steam cooled version, the fuel pin requirements are compiled for both cases. The comparison of the two concepts underlines some principal common conditions. A few very marked differences however—especially the quite different external pressure load from the cooling medium—suggest a specifically adapted layout. The pin layout characteristics, proposed in detailed reference designs, translate the principal requirements to real designs and also to fuel and pin specifications. These important consequences of the basic ideas are discussed in the light of present knowledge and fabrication know-how. The realistic fabrication possibilities and the available experience on oxide pin performance lead to serious limitations, e.g., considering the radial swelling problem. The future development lines concerning fuel types and pin features are shortly mentioned and compared to possible future fuel requirements. (auth)

7805 (EURFNR-425) THE PRINCIPLE OF DOUBLE CONTAINMENT AND THE BEHAVIOUR OF AEROSOLS IN ITS RELATION TO THE SAFETY OF REACTORS WITH A HIGH PLUTONIUM INVENTORY. Haefele, W.; Heller, F.; Schikarski, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Oct. 1967. 17p. (KFK-669; EUR-3702). Dep.

Work performed under United States–Euratom Fast Reactor Exchange Program.

The radiation hazard to the environment of a nuclear power plant is influenced by the course of the design basis accident, by the leakage properties of the containment system, and by the inventory of radioactive materials in the reactor. Investigations on the interrelation between containment system, inventory of radioactive material, and the radiation burden to the environment if the activity is accidentally released are discussed. Special emphasis was paid to the release of various fission products and fuel isotopes, particularly I_2 and Pu, because of their representing the largest hazard potential to the environment of a large fast breeder reactor. The calculations were performed for the case of a typical large fast Na cooled breeder of 1000 MW(e). Discussed are: (1) the influence of the release parameters and the release models, particularly the aerosol model, on the accident doses for typical single and double containment systems, (2) the significance of the decontamination of the containment atmosphere either by natural plate-out or by artificial means like filter systems, and (3) conclusions for the most effective containment system. (auth)

7806 (GA-1100(Suppl.1)) MARITIME GAS-COOLED REACTOR PROGRAM. SAFEGUARDS REPORT FOR THE MGCR CRITICAL EXPERIMENT. Levine, S. H.; Goodjohn, A. J. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Nov. 3, 1960. Contract AT(04-3)-187. 31p. Dep. CFSTI.

Topics discussed include: population density studies for the La Jolla and San Diego areas; the description of the critical assembly; graphite configuration for the critical assembly; description of the magnet and rod contact interlock and lower-limit interlock; description of core restricting channels and angle bracing; arrangement of fuel channels and configuration of fuel elements; schematic diagram of electronic monitor and safety channels; schematic diagram of relay system; airborne activities analysis; and inhalation dose plots for various distances from the reactor site. (D.C.C.)

7807 (GEAP-5494) RAPFU: A COMPUTER CODE FOR RAPID CALCULATION OF FUEL CYCLE PHYSICS PARAMETERS IN FAST BREEDER REACTORS WITH VARIABLE FISSILE RECYCLE SCHEMES. Greebler, P.; Cowan, C. L. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). May 1967. Contract AT(04-3)-189. 66p. Dep. CFSTI.

RAPFU, a fairly simple code, was programmed in FORTRAN IV to permit rapid calculation of equilibrium fuel cycle isotopics in fast breeder reactors. The recycled Pu is permitted to have different isotopic compositions in two different core zones, and several recycle schemes are available as options. Output data includes the initial, average, and discharged fuel isotopic concentrations for each region of the core zones and the blankets, breeding ratio, doubling time, and (optionally) fuel costs calculated using simplified relationships. The flow of calculations performed, options and limitations, input and output data, and the FORTRAN code statements are presented. The range of applicability is illustrated in two sample problems. For a typical case using five core and blanket regions and the most complicated recycle scheme, the computation converged after 12 iterations. The total running time on the G.E.-635 computer was less than one minute. (auth)

7808 (GEAP-5522) SODIUM-COOLED REACTORS FAST CERAMIC REACTOR DEVELOPMENT PROGRAM. Quarterly Report No. 23, May–July 1967. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Aug. 1967. Contract AT(04-3)-189. 102p. Dep. CFSTI.

Post-irradiation examination of a diving-bell-vented fuel specimen (B3F) after 23,500 MWd/Te at 13 to 15 KW/ft irradiation indicated release fractions of 10^{-9} for ^{95}Zr and ^{144}Ce and 10^{-3} for ^{137}Cs. The γ scan for the B3F is presented. Graphical representation of Xe and Kr activity released to the stack of a 3000 MW(t) fast reactor is presented. Transient irradiation of the four axially-restrained, zero-burnup, pelleted fuel specimens (C4A-D) resulted in cladding failure in the 90 percent smeared density samples but no damage in the 80 percent smeared density specimens. Radiographs and γ scans are presented for capsule specimens of varying irradiations. Also, fuel section macrographs are presented for selected specimens. Post-irradiation γ scan of 60,000 MWd/Te burnup specimen is presented. Multiplication constant differences between diffusion theory and discrete ordinates S_4 transport theory for spherical Na-cooled fast oxide reactors are compared. Errors in multiplication compared with mesh interval size for spherical fast oxide reactor with blanket are presented. Parameters effecting fuel performance are presented for cladding thickness, gap conductance, pellet density, sintering temperature, pin size, coolant temperature, and conductivity uncertainty. (D.C.C.)

7809 (NAA-SR-12410) CARBON REMOVAL FROM SRE SODIUM FOLLOWING PEP MODIFICATIONS. May, H. D. (Atomics International, Canoga Park, Calif.). Nov. 1, 1967. Contract AT(04-3)-701. 73p. Dep. CFSTI.

Results of carbon-removal operations and related tests carried out on the SRE Na coolant following the Power Expansion Program modifications are given. Chemical, microhardness traverse, and metallographic methods for measuring Na carburizing effects are described and evaluated. Results of measurements on Type 304 stainless samples, exposed at 1200 to 1300°F for 70 to 450 hours, are presented and analyzed. (M.L.S.)

7810 (NP-17142) ANNUAL REPORT TO THE PRESIDENT, 1967 [ON NUCLEAR TECHNOLOGY]. Welch, Nathaniel (Southern Interstate Nuclear Board, Atlanta, Ga.). Oct. 10, 1967. 27p.

The annual report for 1967 of the Southern Interstate Nuclear Board is presented. Nuclear power plants, in either construction or planning stage, in the Southern Interstate Nuclear Board area are tabulated. Kilowatt power output and investment are presented. Other administrative functions of SINB are discussed. (M.L.S.)

7811 (NUCLEX-66, Paper 3) DIE LOESUNG EINIGER TECHNOLOGISCHER ASPEKTE BEI DER ERZEUGUNG DES DRUCKGEFAESSES DES ERSTEN TSCHECHOSLOWAKISCHEN KERNKRAFTWERKES. (The Solution of Some Technological Aspects for Production of Pressure Vessels for the First Czechoslovakian Nuclear Power Plant). Filip, Radislav; Indra, Jaroslav (Skoda Works, Pilsen (Czechoslovakia)). 14p. (In German).

For manufacture of the reactor pressure vessel several special-purpose machines have been developed and the most significant ones are described. The manufacturing technology of flange and branch rings and of top and bottom spherical caps is considered. (auth)

7812 (NUCLEX-66, Paper 4) ZUM PROBLEM DES SCHWEISSENS DES TSCHECHOSLOWAKISCHEN REAKTORDRUCKGEFAESSES. (The Problem of Welding Czechoslovakian Reactor Pressure Vessels). Becka, Josef (Skoda Works, Pilsen (Czechoslovakia)). 17p. (In German).

The experimental checking of circumferential welds made by hand, arc welding, semiautomatic carbon dioxide shielded welding, and electroslag welding on shortened reactor tanks has enabled the optimum concept of the pressure vessel for the first Czechoslovak Nuclear Power Station to be determined. (auth)

7813 (NUS-415) REACTOR OPERATION'S SAFETY ANALYSIS MONTHLY REPORT NO. 28, OCTOBER 1 TO OCTOBER 31, 1967. (NUS Corp., Washington, D. C.). Contract AT(11-1)-651; Subcontracts No. 4 and 5. 101p. Dep. CFSTI.

For Rural Cooperative Power Association, Elk River, Minn.

An operations history of the Elk River Reactor for the month of October is given. Activity levels in the secondary water system and turbine air ejector systems are shown. Iodine levels in the primary coolant were observed. Results of calculations for the refueling pattern for the third fuel cycle are presented. Results of fuel element examination are given. (M.L.S.)

7814 (ORNL-4178) TERRESTRIAL LOW-POWER REACTOR PROGRAM. Quarterly Progress Report for Period Ending June 30, 1967. (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 40p. Dep. CFSTI.

Design data and operating conditions are presented for a 1.5 MW(E) boiling water plant to be used for terrestrial low power systems. Parameters and performance data are given for a 1.5 MW(E) self-pressurized water reactor. Limiting critical radii are given for a 1.5 MW(E) BWR; void coefficients and radial flux factors are tabulated; values for fast and thermal fluxes at the pressure vessel are listed. Corrosion and water chemistry in small water-cooled reactors are discussed; calculated values of pressure drops in annular fuel channels with boiling water are given. (M.L.S.)

7815 (ORNL-NSIC-40) INDEXED BIBLIOGRAPHY OF CURRENT NUCLEAR SAFETY LITERATURE. II. (Oak Ridge National Lab., Tenn.). Nov. 1967. Contract W-7405-eng-26. 523p. Dep. CFSTI.

An indexed bibliography of nuclear safety literature as of Nov. 1967 is given. Categories cover information on: general safety criteria; siting of nuclear facilities; transportation and handling of radioactive materials; aerospace safety; accident analysis; reactor transients; kinetics, and stability; fission product release, transport, and removal; sources of energy release under accident conditions; nuclear instrumentation, control, and safety systems; electrical power systems; containment of nuclear facilities; plant safety features; radiochemical plant safety; radionuclide release and movement in the environment; environmental surveys, monitoring and radiation exposure of man; meteorological considerations; operational safety and experience; and safety analysis and design reports. (M.L.S.)

7816 (ORNL-TM-2057) ORNL NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROGRAM BIMONTHLY REPORT FOR SEPTEMBER-OCTOBER 1967. Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). Nov. 27, 1967. Contract W-7405-eng-26. 131p. Dep. CFSTI.

CONTAINMENT SYSTEMS EXPERIMENT—fission product aerosols simulation for
CONTAINMENT RESEARCH INSTALLATION—fission product aerosol concentration as a function of time, measurements of
AEROSOLS—concentration of fission product, measurement in CRI of time-dependence of; filtration of solid fission-product
FISSION PRODUCTS—distribution of, comparison of measurements in CMF and CRI of; transport in containment vessels, development of analytical models for describing; behavior in gas-liquid systems; release and transport from steam-carbon reactions
REACTOR FUELS—fission products from uranium dioxide, effects of high heat rating operation on prompt release of
REACTOR CONTAINMENT STRUCTURES—fission product transport in, development of analytical models to describe; designs of, analysis of antiseismic
REACTOR CONTAINMENT SYSTEMS—spray systems for, evaluation of; safety analysis reports on, CHORD-S retrieval system for information from
NUCLEAR SAFETY PILOT PLANT—spray systems performance in, effects of drop size distribution on
HYDROGEN—production of radiolytic, effects of cobalt-60 gamma radiation on
IODINE—removal from air, efficiency of iodized charcoals for; sampler with honeycomb section, distribution of iodine-aerosol mixture through; distribution between sampling tank and low-pressure impactor
RARE GASES—removal from air, use of permiselective membrane for
REACTOR SAFETY EXPERIMENTS—fission product behavior in LOFT, characterization of
IODIDES—formation of organic
CHARCOAL—adsorbers of, ignition by fission product decay heat of
STEAM—reactions with carbon, fission product release and transport from; reactions with graphite, high temperature gas cooled reactor in-pile loop simulation of
CARBON—reactions with steam, fission product release and transport from
GRAPHITE—reactions with steam, high temperature gas cooled reactor in-pile loop simulation of
ORNL RESEARCH REACTOR—capsule facility for, high temperature gas cooled reactor nuclear safety tests in poolside
PRESSURE VESSELS—steels for, materials properties and integrity of; steels for, fracture behavior for; nozzles for, analytical and experimental studies for
NOZZLES—analytical and experimental testing of pressure vessel
PIPES—design criteria for nuclear installation
PUMPS—design criteria for nuclear installation
VALVES—design criteria for nuclear installation
REACTOR FUEL ELEMENTS—shipping casks for irradiated, development of design criteria for
INFORMATION RETRIEVAL SYSTEMS—CHORD-S, for retrieval of, information from safety analysis reports
REACTORS—construction and operation of, listing of approved DRDT tentative standards for
MOLTEN SALT BREEDER REACTOR—reactivity of, calculation of temperature coefficients of; stability analysis of, preliminary; heat exchanger for, afterheat production in fuel loop
REACTIVITY—calculation of MSBR temperature coefficient of
HEAT EXCHANGERS—afterheat generation in MSBR fuel loop
(M.L.S.)

7817 (PRDC-EF-50) POWER REACTOR DEVELOPMENT COMPANY, ENRICO FERMI ATOMIC POWER PLANT REPORT FOR OCTOBER 1967. (Power Reactor Development Co., Detroit, Mich.). Contract AT(11-1)-476. 8p.

Fuel element subassembly handling and inspection, support plate and lower plenum inspection, and gross containment building leak testing of the Fermi Fast Breeder are discussed. Health physics evaluations of gaseous and liquid samplings, smear and air particulate radiation surveys, and sodium activity levels are tabulated. Maintenance of and modification to the reactor plant

are discussed; instrumentation modifications are outlined. Leak rate testing of electrical penetrations of the containment building is discussed. (M.L.S.)

7818 (PRWRA-116) REACTOR OPERATIONS AT THE BONUS PLANT. Monthly Report No. 7, July 1967. (Puerto Rico Water Resources Authority, San Juan). Contract AT-(40-1)-2672. 23p. (WRA-B-67-17).

Topics discussed include: operation log and shutdown explanations; radiation monitoring of air effluent; liquid waste activity analysis; and maintenance. (D.C.C.)

7819 (TRG-Report-1424) FUEL MANAGEMENT STUDIES FOR THE DUNGENESS B REACTOR. Billington, D. E.; Dean, M. H. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Feb. 17, 1967. 24p. Dep. CFSTI. UK 3s. 6d.

The results are presented of an investigation of the problem of controlling the radial form factor, in the quarter core of the Dungeness "B" reactor, using a sophisticated version of the fuel management program, ODYSSEUS, known as ODYSSEUS 2A. The emphasis has been not only on producing improved results for the given situation, but also on developing decision-making routines to automate the program, which can then be used in assessing other problems in fuel management. From the results it can be seen that the radial power form factor is maintained well below 1.30 for most of the range, although the level tends to be high over the early part. It appears that a form factor of 1.28 could be held relatively easily. The discharge irradiation limiters in this version of ODYSSEUS have been successful in removing low discharge irradiation although it is apparent that a further modification to the program is necessary to eliminate the excessively high irradiations obtained in some channels. The feasibility of controlling the approach to equilibrium for the Dungeness "B" reactor by fuel maneuvers alone is thus demonstrated. A prototype automated version of the ODYSSEUS 2A program has been developed which will enable further fuel cycle work to be readily undertaken. (auth)

7820 (TRG-Report-1526) DESIGN AND USE OF SIMPLE REACTIVITY METERS FOR FAST REACTORS. Atkinson, H.; James, P. R.; Tait, D. (United Kingdom Atomic Energy Authority, Dounreay (Scotland). Reactor Group). June 21, 1967. 28p. Dep. CFSTI. UK 4s. 6d.

Reactivity changes in a reactor near critical can be measured more accurately and more quickly by a reactivity meter than by period measurement techniques. Two simple accurate reactivity meter systems (costing less than £1000) were tested on the Dounreay Fast Reactor. These designs, and a description of the experimental measurements and tests, are presented. The simpler system is recommended for use on all fast reactors where reactivity changes are to be measured, and the principle is applicable to other reactor systems where a reasonably smooth current or voltage signal proportional to the reactor power can be obtained. (auth)

7821 (AD-821854) RESEARCH ON HEAT AND MASS TRANSFER. SOME OF THE PREPARATIONS FOR THE CONSTRUCTION OF A NUCLEAR POWER PLANT IN YUGOSLAVIA. Anastasijevic, Predrag; Afgan, Naim. Translated from Nukl. Energ., 2: No. 1, 8-12(1965). 18p. (FTD-HT-66-581). CFSTI.

The heat and mass transfer research activities of the Laboratory of Reactor Heat Engineering of the Boris Kidrich Institute of Nuclear Sciences in Vinca, Yugoslavia, are briefly described. The equipment, procedures, and personnel employed in investigations of gas, water, and liquid metals as heat transfer agents are presented. (H.D.R.)

7822 (AEC-tr-6911) MONTHLY TECHNICAL REPORT [ON GUNDREMMINGEN NUCLEAR POWER PLANT], JANUARY 1967. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). Translation of German report. 47p. Dep. CFSTI. JCL $5.60 fs, $1.82 mf.

An operations history for Gundremmingen Power Plant for the month of January 1967 is given. Results of power tests at 250 MW(E) are discussed; inspection of 6 volt motors, installation of new electrical equipment, valve inspection, and removal of measuring devices on the steam separator are outlined. (M.L.S.)

7823 (AEC-tr-6912) QUARTERLY REPORT NO. 20 [ON SENA REACTOR PROJECT] APRIL 1–JUNE 30, 1967. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-Lez-Givet (France)). Translation of French report. 17p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

An operations history of the SENA power reactor is given for the period April 1–June 30, 1967. Design studies and construction work are summarized. (M.L.S.)

7824 (AEC-tr-6913) UTILIZATION OF DIGITAL COMPUTERS FOR STARTING AND RUNNING THE EDF-3 ATOMIC POWER PLANT. Morin, R. Translated by M. E. Gress (Savannah River Lab., Aiken, S. C.), from Neue Tech., 8: 26-32 (1966). 12p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Uses of a digital computer for operation of the Chinon EDF-3 nuclear power plant are detailed. Types of measurements for which the computer is used are outlined. Direction of sequential operations for startup and shutdown is discussed. Fuel element failure detection is outlined. The computer system is described. (M.L.S.)

7825 STUDIES ON THE OPERATIONS PROBLEMS OF NUCLEAR POWER PLANTS. Meyer, F. (Univ., Bern). Neue Tech., 9: 180-91(Oct. 1967). (In German).

The nuclear power station Kahl has been under power operation since June 1961. The equipment for purification and treatment of radioactive waste water has been proven. The amount of radioactive products originated during operation of the plant is surprisingly small. Operational difficulties concerning the waste disposal plant have not occurred. The public regulations regarding the release of radioactivities have been easily observed without exception. (auth)

7826 SOME PROBLEMS OF NUCLEAR REACTOR FUEL CYCLES. Dyula, Chom (Budapest Polytechnical Inst.). Teploenergetika, 9: 85-7(Sept. 1967). (In Russian).

Two criteria of fuel usage are the megawatt-days of electricity per metric ton delivered to the user $H = E_e/G$, and the material usage efficiency $\eta = (H/H_{max})\ 100 = E_e 100/GH_{max} \cdot H_{max}$ is the energy content of a unit weight of natural nuclear fuel under conditions of complete usage ($H_{max} = 8.5 \times 10^5$ megawatt-days per ton). The fuel weight G includes the losses during enrichment, the amount of fuel in inventory and other fuel losses in addition to the fuel in the reactor. The burn-up, thermal conversion efficiency, and fuel recovery are taken into account in the formulas. Approximate values of these criteria have been calculated for a number of reactors (Calder Hall, Chapelcross, Berkeley, Hinkley Point, Yankee 1, Shippingport 1, Dresden and others). The Shippingport reactor appears relatively good in the comparison because of its high specific electrical productivity H and its low specific fuel loading. (TTT)

7827 DEVELOPMENT OF FAST BREEDERS. Leipunskii, A. I. At. Energ. (USSR), 23: 396-402(Nov. 1967). (In Russian).

A brief review is given on the work carried out with fast reactors in USSR. The reactor physics, thermophysics and technology of liquid Na, corrosion of construction materials, fuel elements, reactor design and its cycles are discussed. Economical aspects and construction of large nuclear power stations powered by fast reactors are also discussed. (R.V.J.)

7828 THE NUCLEAR POWER PLANT WITH BN-350 REACTOR. Leipunskii, A. I.; Afrikantov, I. I.; Orlov, V. V.; Pinkhasik, D. S.; Koshkin, Yu. I.; Shiryaev, V. I.; Baklushin, R. P.; Sharonov, V. I.; Kiselev, G. V.; Milovidov, I. V. At. Energ. (USSR), 23: 409-16(Nov. 1967). (In Russian).

Data are given on the construction and equipment of nuclear power stations powered by BN-350. A brief review is presented on the basic technological equipment in the power stations. The construction of the reactor vessel, coolants, and steam generators are described. Tests with the first and second loop pumps are described. 33 references are included. (R.V.J.)

7829 RESEARCH CENTER OF NUCLEAR REACTORS. Nikolaev, N. A.; Kazachkovskii, O. D.; Ostreikovskii, E. P. At. Energ. (USSR), 23: 439-45(Nov. 1967). (In Russian).

Theoretical and experimental data obtained with the power plant installations developed by the Research Inst of Nuclear Reactors are reviewed. Data are given on the material studies, radiochemistry, waste storage, operation and performance of the power plant powered by VK-50 and Arbus reactors. Data on reactor material technology are discussed. (R.V.J.)

7830 TECHNOLOGICAL PROGRESS IN THE FIELD OF NUCLEAR FUELS: ENEL AND CISE CONTRIBUTION TO IT. Sani, L. (Ente Nazionale per l'Energia Elettrica, Rome). Energ. Nucl. (Milan), 650-8(Nov. 1967).

The role of nuclear fuel in power station economy is discussed. The importance of the problems associated with specific power, burnup increase, and neutron economy improvement are analyzed. Utilization of Pu fuels in thermal reactors and the research work on a fuel element type for the CIRENE reactor are described. The possibility of increasing the Garigliano reactor power density and determining the performance and operating limits of chemical shim cores in the Trino power reactor are discussed. (M.L.S.)

7831 SMALL UTILITY NUCLEAR POWER PLANTS: THEIR PERFORMANCE AND MARKET POTENTIAL. Marchaterre, John F. Reactor Fuel-Process. Technol., 10: 189-9(Summer 1967).

The feasibility of using small nuclear power plants for commercial power production is considered. Experience with the Big Rock Point, Elk River, La Crosse, Humboldt Bay, Pathfinder, BONUS, CVTR, Hallam, Peach Bottom, and Piqua plants is discussed. Data on the reactor cores and facilities are tabulated. Commercial availability and economic status are discussed. 9 references. (M.L.S.)

7832 AEC REVISES GENERAL DESIGN CRITERIA FOR NUCLEAR POWER PLANTS. Reactor Fuel-Process. Technol., 10: 20-5(Summer 1967).

A description of the AEC's revision of general design criteria for nuclear power plants is presented. The nine groups—including overall plant requirements, protection by multiple fission-product barriers, nuclear and radiation controls, reliability and testability of protection systems, reactivity control, reactor coolant-pressure boundary, engineered safety features, fuel- and waste-storage systems, and plant effluents—are detailed. (M.L.S.)

7833 HIGH PRESSURE GAS AS A HEAT TRANSPORT MEDIUM. Symposium Held at London, March 9–10, 1967. Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 1-282(1966-67). (CONF-670327).

Separate abstracts were prepared for the 30 papers presented, which related to the aspects of primary circuits, gas flow, gas circulators, turbines, and heat transfer in nuclear reactor systems. (UK)

For abstracts of individual papers see: 7834–7863.

7834 USE OF GAS COOLING IN NUCLEAR POWER REACTORS Thorn, J. D. (United Kingdom Atomic Energy Authority, Risley, Eng.). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 1-8(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

The original reasons for the selection of high pressure gas as the primary heat transport medium at Calder Hall are briefly reviewed. From the aspect of heat transport this was not the obvious choice, other fluids such as water having a more favorable combination of properties. Other considerations, such as controllability and the need to use natural U, were judged to outweigh the potential disadvantage of gas in heat transport and heat transfer. The situation is examined in the light of present knowledge. As a result of technological developments the economic disadvantage of gas in heat transport and heat transfer has been diminished. The trend of development over the past ten years has supported the original decision to use gas. Some of the further developments which may be possible in the next ten years are examined, and it is concluded that gas-cooled systems are very likely to maintain or enhance their relative position in this period. (auth)

7835 THERMODYNAMIC COMPARISON OF GAS COOLANTS FOR NUCLEAR REACTORS. Melese-d'Hospital, G.; Fortescue, P. (General Dynamics Corp., San Diego, Calif.). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 9-16(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

Both CO_2 and He are in use as power reactor coolants, and in addition steam has been proposed for this purpose. These are compared from the standpoint of thermodynamic performance. Questions of relative availability and chemical compatibility are not considered. Although all three gases are capable of removing approximately the same thermal power for given pumping power, helium requires less heat transfer area, while carbon dioxide and steam give much higher pressure drop. In spite of its good heat transport properties, saturated steam is detrimental to the nuclear characteristics of fast reactors. A perhaps unexpected conclusion is that the relative merits of these coolants is quite appreciably influenced by whether smooth or rough surfaces are employed. (auth)

7836 GAS-SOLIDS SUSPENSIONS AS HEAT TRANSFER MEDIA. Woodcock, M. T.; Worley, N. G. (Babcock and Wilcox Ltd., London). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 17-33(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

The addition of μ-sized solid particles to a gas considerably improves its heat transfer and transport properties, and it has long been recognized that many closed-circuit systems which use gas could be greatly improved if gas-solids suspensions could be successfully developed as heat transfer media. It has been found from the experimental work that the handling of these mixtures is not unduly difficult (in particular, standard types of blowers such as the Roots type being suitable for circulating them), and that the heat transfer and pressure drop characteristics from heated tubes and rod-clusters are encouraging and reproducible. The process by which heat is removed from a gas-solids suspension has, however, received relatively little study, and hence part of the development programme carried out in UK has concentrated on the technology of this process, using cross-flow tubular heat exchangers. The results show that deposition need not be a problem, and that very high heat transfer coefficients with relatively low pressure drop factors can be obtained with a gas-solids suspension. A comparison of the thermal performance of a nuclear reactor boiler using a clean gas or a gas-solids mixture is given. (auth)

7837 PRIMARY CIRCUITS FOR GAS-COOLED REACTORS. Bennett, J. C.; Turton, P. J. (Atomic Power Constructions Ltd., Sutton, Eng.). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 34-40(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

The design is discussed of primary circuits for gas-cooled reactors in which high density and high temperature gas flows in a closed loop, carrying heat from fuel elements in the core to banks of boiler tubes. The Dungeness 'B' primary circuit is briefly described and serves as an illustration of the design problems and their solution. The problems met are associated with the means of segregating the hot from the cool gas flows, the methods of distributing the required amount of cooling flow to the various parts of the circuit, the design for minimum pressure loss, which frequently conflicts with the requirements of radiation shielding and convenient construction, and the effects of differential temperatures round the circuit. Vibration problems are not dealt with. (auth)

7838 PUMICE CONCRETE, THERMAL INSULATOR IN A GAS UNDER PRESSURE. Tarbes, B. (Societe des Grands Travaux de Marseille, Paris); Menestrier, S. Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 41-7(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

Insulators made of porous material ('random' insulators) are compared with insulators made of organized metallic cells ('systematic' insulators). It is pointed out that random insulators are generally less susceptible to heat loss caused by convection, that they are strong, and that they can be adapted to new or unusual forms without the necessity for any readjustment or new tests. The difficulties involved in taking advantage of the above qualities are examined. It is most important to obtain a surface without joints, which will not develop any serious cracks during a lifetime of 20-30 years. To ensure this the porous material must have a number of mechanical qualities not readily found—suitable strength, flow, shrinkage, thermal expansion—and these are discussed. A description is given of how these requirements determine (a) the choice of materials (pumice stone, cement); (b) the precautions to be taken and the processes necessary during manufacture (checking of materials, sorting of aggregates, heat treatment, concreting method, artificial ageing, assembly of prefabricated blocks). In conclusion, it is noted that these materials open up a promising line of research for insulators in gas under very high pressure or even in water. (auth)

7839 HEAT TRANSFER BEHAVIOUR OF METALLIC FOIL INSULATION IN HIGH PRESSURE GAS. Davidson, J. (Nuclear Power Group Ltd., Knutsford, Eng.). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 48-56(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

The advent of concrete pressure vessels in nuclear power stations has necessitated the use of stainless steel foil insulation in high pressure gas environments. Measurements of the effective conductivity of a vertical pack of insulation at high gas pressures have indicated that not only is the mean conductivity of the pack a function of gas pressure, but also that variations in apparent conductivity with height occur. A model is postulated, in which the insulation acts as an anisotropic porous solid, the permeabilities parallel and perpendicular to the plane of the foil layers being markedly different. Equations describing gas movement and heat flow within this porous medium are deduced, and a method of solution of these equations for vertical packs of insulation with the vertical faces at different temperatures is given. A particular form of foil insulation, for which the measured values of permeability coefficients are available, is considered. The variation of effective conductivity of the pack with height, arising as a result

of gross convection currents within the pack, is examined, and compared with measurements. (auth)

7840 EFFECT OF CARBON DIOXIDE GAS PRESSURE ON THE THERMAL CONDUCTIVITY OF SOME GRANULAR INSULATIONS. Sanderson, P. D. (English Electric Co. Ltd., Whetstone, Eng.); Garratt, V. E. W. Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 57-65(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

Loose fill granular thermal insulations have certain applications in nuclear power stations where the working environment is pressurized CO_2. A programme of work to provide thermal conductivity data for three mineral granular insulations under such conditions was extended to cover a range of CO_2 gas pressure from 5 μ Hg to 450 psia in order to obtain some basic information of the mechanism of heat transfer in such materials. Throughout the investigation the hot face temperature was maintained at about 300°C and the cold face temperature at about 10°C. It was found that although the absolute levels of thermal conductivity of the three materials were markedly different, the forms of the variation of thermal conductivity with CO_2 pressure were similar. From CO_2 pressures of 5 μ Hg up to the order of one atmosphere the thermal conductivity was found to be strongly dependent on CO_2 pressure, whereas at pressures greater than this up to 450 psia only a weak dependence was shown, with no indication of the occurrence of natural convection effects even at the highest pressures reached. The results demonstrate the important role that free molecule conduction can play at or near the contact areas between the particles. Under the test conditions radiation was calculated to increase the effective thermal conductivity by approximately 5 per cent. A literature survey is also presented which covers both experimental and theoretical work on the thermal conductivity of granular insulations. (auth)

7841 THE PROPAGATION OF SOUND, WITH SPECIAL REFERENCE TO HIGH PRESSURE GAS CIRCUITS. Fahy, F. J.; Richards, E. J. (Univ. of Southampton, Eng.). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 66-72(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

Small perturbation equations for an ideal gas are used to show the importance of the p/ρ relationship for the speed of sound. Real gas and finite disturbance effects on sound speed and absorption are considered for typical gas circuits. Local hydrodynamic pressure fluctuations are distinguished from sound. The homogeneous wave equation is derived, and the meaning of the solutions in unbounded media leads to a brief consideration of acoustic sources in terms of the elementary source. Solutions of the wave equation in bounded media are discussed and modal analysis, as applied to ducts and closed volumes, together with some statistical approaches, are introduced. Plane wave energy propagation is considered. The major differences between sound propagation in high pressure gas and in atmospheric conditions are the different absorption characteristics of the gases, the relatively higher sound pressures produced by a given source, and the dependence of boundary absorption on the density and speed of sound in the gas. (auth)

7842 DETECTION AND MEASUREMENT OF ACOUSTIC AND STRUCTURAL VIBRATION IN HIGH PRESSURE GASES. Webb, J. D.; White, J. B. (English Electric Co. Ltd., Whetstone, Eng.). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 73-80 (1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

The design and development of instrumentation for measuring the acoustic pressure levels and structural vibration are described, with particular regard to the ductwork and vessel of magnox type nuclear reactors. (auth)

7843 ACOUSTICALLY INDUCED STRESSES IN NUCLEAR STRUCTURES. Yeh, L.; Beaney, E. M.; Smith, B. (English Electric Co. Ltd., Whetstone, Eng.). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 89-103(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

An experimental verification of existing theories which predict acceleration levels of flat panels in reverberant acoustic fields is described. An extension was made to calculate stress from these acceleration levels. The application is to plates and panels in nuclear reactor pressure circuits. The technique, though universally applicable, is described in terms of an experiment on a model dome-shaped vessel. Such a structure has a multi-modal response, and stresses vary with respect to both time and space. Strain gauge measurements give both maximum and r.m.s. stresses as a function of noise intensity, and these can be extrapolated to service conditions. The results provide information from which the fatigue life of the structure under service conditions may be estimated. (auth)

7844 CONTROL OF FLOW IN REACTOR FUEL CHANNELS. Holmes, N. A.; Dean, B. G. (Atomic Power Constructions Ltd., Heston, Eng.). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 104-9(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

In general, gas-cooled reactors consist of an upper and a lower chamber connected by many fuel channels in the graphite core. Control of flow in the channels is discussed and some typical designs are described, including that for Dungeness "B". The advantages of single channel access are listed. Channel resistance must be determined experimentally before the reactor design can be finalized, and information from various sources is used to compute the chamber to chamber pressure drop. The predicted flow in the fuel channels was confirmed experimentally, and measurements made on the loaded core are described. (UK)

7845 PRACTICAL EXAMPLES OF CYLINDRICAL WAVES IN POWER PLANTS. Lawson, R.; Scott, H. L. (English Electric Co. Ltd., Whetstone, Eng.). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 110-19(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

Some examples are given of the occurrence of cylindrical acoustic waves in modern power plants, together with an introduction to the basic theory. The theory of three-dimensional wave systems in ducts is presented in a concise and comprehensive form. The four types of wave motion which exist, and the conditions for their occurrence, are described. The examples deal with the occurrence of cylindrical waves in axial compressors, duct systems, and a cylindrical orifice system used for flow control in nuclear reactors. The first example presents some measurements of cylindrical acoustic wave systems in axial compressors, and describes how the noise spectrum can be modified by altering the numbers of waves. The second example considers a problem which arose in practice, in which a symmetrical row of orifices in a cylindrical duct generated an intense sound field. The characteristics of the sound field are discussed in detail. Body forces in ducts caused by certain cylindrical wave systems, and the resulting severe vibrations which may occur, are also discussed. Emphasis is placed on presenting the theory in a manner useful to the practising engineer, and the various aspects of the theory are, where possible, related to practical examples of noise generation in power plants. (auth)

7846 TRENDS IN DESIGN OF BLOWERS FOR GAS-COOLED REACTORS. Fraser, W. M. (James Howden and Co. Ltd., Glasgow). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 120-8(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

Present-day duties for gas circulators for large gas-cooled reactors have resulted in a trend towards centrifugal machines with submerged motor drive. There are many reasons for this trend, varying from the straight-forward matters of aerodynamic selection and deletion of shaft seal to the more complex problems of impeller rigidity, noise generation, full-scale works testing and the like. A case is made for the selection of compact 3000 rpm centrifugals with inlet guide vane control for the latest AGR station at Hinkley Point "B", and some of the main points of consideration in this selection are outlined. (auth)

7847 GAS CIRCULATORS FOR FRENCH POWER REACTORS. Strub, R. A. (Sulzer Bros., Ltd., Winterthur, Switzerland). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 129-37 (1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

The design of the CO_2 circulator for the first atomic power plant Chinon EDF 1 in France is presented. This single blower of about 9 MW is driven at constant speed by two electric motors placed in series. Flow regulation is made by means of variable guide vanes. Shaft sealing is effected by a double oil seal having floating rings at the atmospheric side and a mechanical seal at the impeller side. After a blade failure due to bending fatigue during starting at low speed, and a bearing failure due to insufficient balancing at low speed (the unit running above the first critical speed), the unit has accumulated on all the parts more than 12,500 hr of trouble-free operation. In particular, the shaft seal is exceptionally good. The rate of wear is of the order of 0.004 in. for 10,000 hr operation. The design of the first integrated circulator units of St. Laurent I and II is discussed, showing a marked advance in the layout, when compared with the circulator of Chinon I. The four units per re-

actor have no inlet guide vanes and no diffuser vanes. Flow regulation is made by a variable speed turbine drive. No valve is incorporated in the design. If one unit is not running, a certain amount of gas is by-passed through it. The small reduction from 83 to 74% of gas flow circulating through the reactor core can be regarded as negligible. (auth)

7848 TOTALLY ENCLOSED BLOWERS WITH GAS-LUBRICATED BEARINGS. van Zijl, N. A.; Eggmann, J. (British Brown Boveri Ltd., London). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 138-47(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

The main principles of gas lubrication and the properties of different types of gas bearings are briefly discussed. Emphasis is mainly on the design of gas-bearing blowers, especially in relation to the primary cooling gas circulators as supplied for the Dragon Reactor Experiment. The operating record of these circulators, which have been in operation since August 1964, is briefly reported and shows that gas-bearing blowers are reliable and suitable for long continuous service. The different methods of drive and control for gas-bearing blowers are also discussed. For blowers operating at a speed higher than 3000 rpm, frequency changers must be provided. A summary is given of variable frequency generators that can be used in conjunction with gas-bearing blowers. (auth)

7849 SHAFT SEALS FOR GAS CIRCULATORS. Gibson, W. H.; Little, J. A. (C. A. Parsons and Co., Ltd., Newcastle-upon-Tyne, Eng.). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 148-55(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

The development of oil-fed hydrodynamic gas seals for the circulators of a succession of CO_2/Magnox reactors is described. In these stations the design gas pressure was progressively increased from 100 to 380 psig and the gas temperature from 140 to 245°C. The seals are of the flat radial face type in which a plane collar on the shaft runs against a stationary seal. The seal is free to follow axial movements of the collar, being contained in its housing by rubber U-rings. Sealing of the gas is achieved by supplying oil to a circumferential groove in the radial face of the seal at a pressure slightly higher than gas pressure. The outer portion of the seal face, over which oil flows to the atmospheric drain, is provided with radial grooves to permit adequate oil flow to cool the seal and form thrust pads for hydrodynamic operation. The inner portion of the face forms a continuous sealing ring. Because of the combination of hydrodynamic, hydrostatic, and friction forces acting on the seal, the spring forces required to give adequate sealing without wiping at all operating conditions can at present be determined only by experiment. Satisfactory sealing and mechanical performance have been obtained with estimated hydrodynamic pressures of 50 psi at surface speeds of 150 fps. Complete trapping of the small flow of oil leaving the gas side of the seal before it reaches the gas circuit required continuous development of improved oil separating arrangements with the increasing gas pressure and temperature of successive designs. (auth)

7850 ASSESSMENT OF THE COMPONENT SIZES OF NUCLEAR CLOSED-CYCLE GAS TURBINES USING ARGON AND HELIUM. Ainley, D. G.; Barnes, J. F. (National Gas Turbine Establishment, Farnborough, Eng.). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 156-62(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

The calculations for heat exchanger, turbine, and compressor sizes are based on a power output of 250 MW and a maximum gas pressure of 40 atm. The highest practicable gas temperatures are determined in relation to the turbine blade speed and the gas used. In the absence of blade cooling, turbine inlet temperatures of 1100°K for He and 1250°K for Ar are found. A preferred form of gas turbine plant is proposed with a gross thermal efficiency of 35 to 45%, and it is shown how the thermal efficiency and component sizes of such a plant will be influenced by the choice of working gas. (UK)

7851 HEAT TRANSFER AND PRESSURE DROP ALONG HERRINGBONE FINNED SURFACES. Malherbe, J.; Cornille, Y.; Pelce, J. (CEA, Saclay, France). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 163-71(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

A polyzonal chevron arrangement makes it possible to obtain, for very high Reynolds numbers, appreciably better heat exchange than with longitudinal or transverse fins. A formula for chevron arrangements, resting on theoretical bases and readjusted on a large number of experimental results, has been established. It gives the characteristics of heat transfer and pressure drop as functions of principal parameters which are the dimensions of the fins, their pitch, and their inclination. Other secondary parameters, such as grooves or the divisions between the sectors and the curvature of the finned surfaces (e.g. external or internal can of the annular element), do not figure explicitly in the formula, but their influence can, however, be sensible. (UK)

7852 DEVELOPMENT OF HIGH PERFORMANCE HEAT TRANSFER SURFACES FOR REACTOR FUEL ELEMENTS. Furber, B. N. (Nuclear Power Group Ltd., Knutsford, Eng.); MacGillivray, D. A.; Vivian, W. R. Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 172-80(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

In the development of magnox fuel elements to ratings approximately two to three times as high as those which can be achieved with solid rod fuel, the heat transfer performance of finned cylindrical and plane surfaces was investigated in order to develop a surface channel arrangement with high heat transfer and low pressure drop at high Reynolds number. Axial, spiral, polyzonal, and herringbone finned surfaces were studied, and the experimental techniques used are briefly described. Investigations of the factors influencing fin efficiency, flute and free stream gas velocities, and temperature distributions were carried out to improve the understanding of the heat transfer mechanism and to enable the performance measured under rig conditions to be connected for the Reynolds number, heat flux, and the complex problem of heat release experienced in the reactor. (auth)

7853 HEAT TRANSFER AND PRESSURE DROP CHARACTERISTICS OF SOME NUCLEAR REACTOR FUEL ELEMENTS WITH HERRINGBONE FINNING. Conway-Jones, A. H.; Marsh, A. (Nuclear Design and Construction Co., Ltd., Whetstone, Eng.). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 181-9 (1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

The need for a design of fuel element that is aerodynamically stable under reactor channel flow conditions, while still providing a high rate of heat transfer from the surface without excessive pressure drop, led to interest in fuel elements with herringbone finning. Heat transfer and pressure drop tests were carried out on various designs of fuel element with this type of finning, with particular application to the development and proving of the elements for the Sizewell and Wylfa Nuclear Power Stations. The results presented include the effects of element bow and of relative element orientation. (auth)

7854 WIDER APPLICATION OF ROUGHENED HEAT TRANSFER SURFACES AS DEVELOPED FOR ADVANCED GAS-COOLED REACTORS. Walker, V.; Wilkie, D. (United Kingdom Atomic Energy Authority, Windscale, Eng.). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 190-7(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

It is sometimes supposed that surface roughening, or other types of "turbulence promoter," are only of interest if they enhance the mechanism of heat transfer more than that of momentum transfer (drag), i.e., increase Stanton number, St, more than friction factor, f. This is a misconception arising from a too narrow examination of the possible ways of employing an increase Stanton number. The opportunities provided by an increase St are discussed in some detail, and comparisons are made between roughening, finned surface, and plain smooth surface. For heat transfer to gases, roughening apparently always increases f more than St, but is nevertheless being used to considerable advantage on the fuel elements of Advanced Gas-cooled Reactors, and for similar reasons could find other applications. The available data for the AGR type of roughness are summarized. (auth)

7855 CONVECTIVE HEAT TRANSFER CORRELATIONS FOR USE WITH HELIUM AT HIGH HEAT FLUXES. Marien, P. J.; Richards, A. D. (Organization for Economic Co-operation and Development, Winfrith, Eng.). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 198-205(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

Sixteen correlations are applied to the prediction of wall temperature in each of three cases: an experimental fuel irradiation loop, the core of Dragon, and that of a 1250 MW(t) power reactor. Where practical measurements are available comparisons are made. Four correlations were applied to further power reactor studies. Considerable variations in predicted temperatures show the importance of checking the range of validity of correlations

used and of the accuracy of gas properties employed. Some correlations are very sensitive to such uncertainties. (UK)

7856 HEAT TRANSFER IN AN ANNULUS WITH LARGE TEMPERATURE DIFFERENCES BETWEEN WALL AND COOLANT GAS. Dalle Donne, M.; Meerwald, E. (Kernforschungszentrum, Karlsruhe, Ger.). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 206-16(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

Experimental local heat transfer and friction coefficients are correlated for subsonic turbulent flow of air through annuli with large temperature differences wall and coolant. The test sections were preceded by a long unheated entrance length. The experiment was performed at a maximum wall temperature of 1000°C, the boundary conditions being those of constant wall heat flux. The recommended formulae are: $Nu_B = 0.0181\ (D_2/D_1)^{0.2}\ Re_B^{0.8}\ Pr_B^{0.4}\ (T_W/T_F)^{-0.18}$ $f_B = 0.0615\ [(D_2/D_1 - 1)/(D_2/D_1)]^{0.1}\ Re_W^{-0.2}$. (auth)

7857 STEAM RAISING UNIT DESIGN. Warren, L. W. (International Combustion Ltd., Derby, Eng.). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 217-26(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

Due to the higher gas temperatures in the AGR at Dungeness, in comparison with the Magnox system, it has been necessary to review the materials used in the boiler to prevent CO_2 corrosion and keep the evaporation end point outside the austenitic region of the plant. The materials and the basic design are described. All the gas circuit is within a concrete pressure vessel, and the four boilers are in the annular space between this and the reactor core. In order to accommodate the boilers in the minimum space particular attention was given to the packing of the boiler heating surface. The implications of high gas mass flow rates, and the adverse features of the tube element support system and the increased vibration potential are considered. (UK)

7858 MANUFACTURE OF FINNED TUBING FOR ECONOMIC HEAT TRANSFER IN HIGH PRESSURE GAS SYSTEMS. Wright, R. (STD Services Ltd., Birmingham, Eng.). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 227-34(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

The essential properties of finned tubing in steam generators are reviewed. An outline is given of the procedures for the production of resistance-welded tubes with fins and studs, and of cold rolled transverse finned tubes. The problems of obtaining a full-face weld, the limitations of the cold rolling process, and the inspection techniques are discussed. (UK)

7859 METALLIC FOIL INSULATION. Hughes, J. W.; O'Tallamhain, C. (Nuclear Power Group, Ltd., Knutsford, Eng.). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 235-8 (1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

Design problems were posed by the need to prevent gas ingress to the insulation of the liner of the Oldbury pressure vessel at points of penetration. These were solved in the main by using 0.004 in. sealing foils shaped and welded to the reactor components. Unsatisfactory performance of the insulation during reactor commissioning was attributed to failure of gas seals, unexpected high pressure gradients, and weld corrosion caused by condensation. Subsequent modifications made to the sealing are outlined. (UK)

7860 CENTRIFUGAL BLOWERS FOR NUCLEAR APPLICATION. Shearer, K. L. (Linde, AG, Surth, Ger.). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 239(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

Brief details are given of designs having a sealed blower/drive unit with coolant-lubricated hydrodynamic bearings for N_2, CO_2, and superheated steam. (UK)

7861 BRIEF DESCRIPTION OF THE HIGH TEMPERATURE GAS LOOP. Petersen, H. (Danish Atomic Energy Commission, Risoe). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 240-2(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

The loop described provides a 4 m test section operating at 20 atm an outlet wall temperature of 1000°C. It is contained in a 0.6 m dia longitudinally split vessel. (UK)

7862 RESEARCH ACTIVITIES IN THE FIELD OF HEAT TRANSFER WITH HIGH PRESSURE GAS. Feijen, J. J.; Van Den Brink, H. W. J.; Schoonen, J. M. W. M. (Technische Hogeschool, Eindhoven, Netherlands). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 243-6(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

A high pressure–high temperature loop is described, designed for research at 950°C and 100 atm, with a secondary circuit capable of producing superheated steam at 500°C and 100 atm. A description is also given of an atmospheric test rig for reactor fuel cans, and a rig operable at 250°C and 15 atm for cross flow experiments on tube banks. (UK)

7863 VIBRATION PROBLEMS IN NUCLEAR POWER PLANT. Derbyshire, J. F.; Stead, R. (Nuclear Power Group Ltd., Knutsford, Eng.). Proc. Inst. Mech. Eng. (London), 181: Pt. 3I, 81-8(1966-67).

From Symposium on High Pressure Gas as a Heat Transport Medium, London, England, Mar. 9–10, 1967. See CONF-670327.

Two independent vibration problems encountered during the commissioning of the Dungeness Nuclear Power Station are described, which were both caused by instabilities in the gas flow in the reactor coolant circuit. They resulted from coincidence occurring between the frequencies of a periodic gas instability, an aerial vibration within the ducting, and a structural natural frequency. The first of these problems affected the reactor bypass circuit, where it was found, during preliminary commissioning trials, that excessive vibration of the ducting was occurring when the gas circulator was operating within a particular range of speeds. The cause of the high vibration level was established at site and remedial action was taken. The second, and more serious, problem occurred in the heat exchangers, where the frequency of a gas pressure pulse generated within the tube banks was coincident at a certain circulator speed with the transverse aerial resonant frequency within the heat exchanger shell. This coincidence caused a pressure pulse of ±3 psi to be generated, which in turn caused severe vibration of certain structural components within the heat exchanger, resulting in observed dynamic stress of ± 10 tsi. Tests with scale models in a laboratory wind tunnel showed that it was possible to reproduce the phenomena experienced in the heat exchanger. The models were then used to indicate possible solutions to the problem, since the accepted method of using longitudinal baffles to increase the frequency of the transverse aerial vibration was not possible without major boiler modifications. A novel method of eliminating the vibration, established in the model, was incorporated in the Dungeness heat exchangers and proved to be satisfactory. (auth)

7864 SAFETY SYSTEM FOR A NUCLEAR REACTOR. Ogasawara, Hideo (to Hitachi Ltd.). Japanese Patent 1966-16919. Sept. 26, 1966. Filed Mar. 10, 1964.

When a failure occurs in a reactor high enthalpy fluid fills the containment vessel. This fluid is then led into the surrounding water-pool to condense it into a liquid. Since the cost involved is large due to the size of the pool, an improved system is presented. The reactor is installed in a "dry well," and the water pool surrounds this dry well; the fluid vapor (at the time of an accident) is led into the pool from the dry well through a long pipe. A means is provided for introducing a liquid (to condense the fluid) at a part of the long pipe between the dry well and the surrounding pool. (NSA of Japan)

7865 SAFETY SYSTEM FOR A NUCLEAR REACTOR. Ogasawara, Hideo (to Hitachi Ltd.). Japanese Patent 1966-18038. Oct. 15, 1966. Filed Mar. 10, 1964.

When a failure occurs in a reactor, high enthalpy fluid fills the containment vessel. This fluid is then led into the surrounding water-pool to condense. An improved system is presented to reduce cost. The reactor is installed in a "dry well," and the water pool surrounds this dry well; the fluid, e.g., vapor (at the time of the accident) is led into the pool from the dry well through two long pipes which extend into the pool in opposite directions. The end of each pipe within the pool is bent in the horizontal "same" direction. The fluid ejected from the pipes flows circumferentially in the pool. As a result, the depth of water in the pool can be shallower than in the ordinary pools. (NSA of Japan)

7866 REACTOR CONTROL ROD. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1966-20917. Dec. 6, 1966. Filed Oct. 16, 1963.

In the proposed reactor control rod, usual control elements, made by filling absorber powder or pellets in tubes, are not used. The advantages to the control rod are uniform distribution of absorber material (throughout the control rod) leading to an increased efficiency of neutron absorption, easy construction, and reduced costs. The control rod consists of the outer tube; the inner tube; neutron moderator in the inner tube; and a number of cases packed tightly with absorber plates, and inserted in the space between the outer and the inner tube. (NSA of Japan)

7867 PLUG FOR SEALING A HORIZONTAL PIPE IN A NUCLEAR REACTOR. Suzuki, Yasuyuki (to Fuji Electric Mfg. Co., Ltd.). Japanese Patent 1966-17799. Oct. 11, 1966. Filed Feb. 29, 1964.

In a stand pipe in a reactor the plug can usually be easily inserted or removed. In a horizontal pipe, however, this becomes difficult. The plug proposed consists of outer and inner cylindrical plungers. Through the wall of the outer cylindrical body, a series of large holes are cut circumferentially. In each hole a spherical body of larger diameter is placed. When the plug is in its "sealing" position, the ejected part of the spheres engages the groove cut on the inner surface of the horizontal pipe. The inner cylindrical body serves to push out the balls by means of tiny spheres on its outer surface which roll in thin grooves cut on the inner surface of the outer cylindrical body and by means of a semispherical hollow also cut on its outer surface into which the large ball goes when the plug is in the horizontal pipe and an internal pressure is applied to the inner cylindrical body, the plug with the mechanism is in the perfect pipe "closing" posture. (NSA of Japan)

7868 METHOD FOR COOLING A NUCLEAR REACTOR. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1966-17800. Oct. 11, 1966. Filed Mar. 6, 1964.

The proposed method is used in the type of reactor in which primary coolant within the reactor removes heat from the reactor core, and secondary coolant is led through the heated primary coolant by piping to generate steam. The advantages obtainable are highly improved heat removal from the reactor core due to the increase of primary coolant circulation, and improved heat-exchange between primary and secondary coolant. It includes the reactor core contained in the reactor pressure vessel from which heat is removed by primary coolant; a number of vertical tubes surrounding the region of reactor core through which secondary coolant flows to absorb heat from the heated primary coolant; and a vapor drum connected to the pipes at their upper end which collects the generated vapor. From the top face of the reactor core extends upwards a cylindrical body for the heated primary coolant. This cylindrical body penetrates the middle of the vapor drum and then connects the space between the pressure vessel and the upper part of the drum. The heated primary coolant after passing through the cylindrical body and the space flows through the space between the vessel and the drum, between the vertical tubes, and finally back into the reactor core. (NSA of Japan)

7869 REACTOR CONTROL ROD. Azuma, Masao (to Hitachi Ltd.). Japanese Patent 1966-16359. Sept. 14, 1966. Filed Aug. 24, 1963.

The proposed reactor control rod is used for the control of a reactor by means of an electronic computer. The control rod consists of the outermost square tube of a neutron absorber such as stainless steel; a square tube of a neutron moderator such as Be surrounded by the outer tube; a square tube made of a neutron-absorbing material enclosed in the moderator tube; and a neutron-flux detecting device of the γ-ray compensated type which is within the inmost tube. (NSA of Japan)

7870 REACTOR CONTAINMENT VESSEL. Haneda, Mikio (to Nippon Atomic Ind. Group Co., Ltd.). Japanese Patent 1966-20916. Dec. 6, 1966. Filed Oct 2, 1963.

In the reactor containment vessel proposed, when high-pressure and high-temperature steam or steam-water mixture is ejected from the reactor through a ruptured pipe or a safety valve the "heat" shock which the vessel receives from the ejected steam can be reduced, thereby protecting the vessel from damage. Heat-shock absorbing plates are attached to the inner surface of the pressure vessel with spacings where the vessel is subjected to heat shocks. (NSA of Japan)

7871 THERMAL-NEUTRON REACTOR. Kanbara, Toyozo (to Hitachi Ltd.). Japanese Patent 1966-20519. Nov. 30, 1966. Filed June 24, 1963.

A thermal reactor with the peculiar control system is proposed. The advantages are high neutron economy, simple core construction, and increased flattening of the neutron-flux distribution. Either around the reactor core, or around and within the reactor core are placed the "surrounding" reflector(s). Within the reflector(s), or between the "outer" reflector and the reactor core are installed a circumferential series of control elements composed of a fertile material. By changing the total effective area of control elements facing the reactor core, the effective amount of absorption of neutrons from the reactor core is changed, and also the reactivity of the reactor. The control element is made up of two layers: one layer is of a fissile material, and the other of a fertile material. The reactivity control is achieved by suitably opposing either of the two layers to the reactor core, and by changing the effective area. (NSA of Japan)

7872 WATER-AND-VAPOR SEPARATING DEVICE FOR A BOILING-WATER REACTOR. Haneda, Mikio (to Nippon Atomic Ind. Group Co., Ltd.). Japanese Patent 1966-18365. Oct. 21, 1966. Filed July 25, 1963.

The water-and-vapor separating device proposed has the advantages of the increased efficiency, the reduced size, and minimization of the (vapor) pressure drop. The first stage consists of a large number of vertical guide-blades a little inclined in the direction of vapor flow for giving the vapor a rotating flow, and many holes arranged around the circumference for separating condensed water-drops from the vapor. The second stage consists of similar guide-blades for separating water and vapor by further promoting the rotational flow from the first stage. The third stage consists of "not inclined" vertical guide-blades for stopping the rotation of flow from the second stage. (NSA of Japan)

7873 SAFETY SYSTEM FOR A NUCLEAR REACTOR. Goko, Hiroshi (to Hitachi Ltd.). Japanese Patent 1966-18039. Oct. 15, 1966. Filed Mar. 16, 1964.

When a failure occurs in a reactor, high enthalpy fluid fills the containment vessel. This fluid then flows into the surrounding water-pool to condense it into a liquid. Since the cost involved is large due to the size of the pool, an improved system is presented. The reactor is installed in a "dry well," and the water pool surrounds this dry well; the fluid, e.g., vapor (at the time of an accident), is led into the pool from the dry well through a long pipe. A part of the long pipe is partitioned below the dry well and the pool by means of two thin plates to give a small room. This room connects a small pipe which, on the opposite side, connects to a water tank located at a high elevation. The small room and pipe are constantly filled with water. At the time of a reactor accident, when vapor flows through the long pipe, the two thin plates are destroyed, and the liquid can be supplied to condense the vapor before it reaches the pool water. (NSA of Japan)

Rocket and Space Reactors

7874 SPACE POWER SYSTEMS ENGINEERING. Third Biennial Aerospace Power Systems Conference held at Philadelphia, September 1–4, 1964. Szego, George C.; Taylor, J. Edward (eds.). Progress in Astronautics and Aeronautics. Volume 16. New York, Academic Press, 1966. 1320p. (CONF-640901).

Presented is a compilation of 57 papers devoted to current technical problems and their solutions and achievements in the engineering of space power systems. Following a section denoted to requirements for space power systems and the problems of application to spacecraft, detailed technical problems of systems design and component research and development are discussed for reactor, radioisotopic, solar, chemical, and magnetohydrodynamic electric power systems. Separate abstracts were prepared for 17 papers. Abstracts of 16 papers appear in previous issues of NSA as CONF-640901. (H.D.R.)

For abstracts of individual papers see: 6539, 6540, and 7875–7889.

7875 APPLICATION OF NUCLEAR ELECTRIC PROPULSION TO UNMANNED SCIENTIFIC PROBE MISSIONS. Widmer, T. F.; Brown, H. (General Electric Co., Philadelphia). Contract NAS-3-2533. Progr. Astronaut. Aeronaut., 16: 115-62(1966).

From 3rd Biennial Aerospace Power Systems Conference, Philadelphia, Sept. 1–4, 1964. See CONF-640901.

Advanced scientific missions throughout the solar system are analyzed to determine payload and velocity requirements for nuclear-electric propelled spacecraft. Emphasis is placed upon those missions that are too difficult for all-chemical propulsion, even with boosters as large as Saturn V. In parallel with the mission analysis, spacecraft designs were prepared, and key problems of power plant integration were investigated. Particular attention is given to the radiator and its effect upon vehicle configuration. The spacecraft integration studies have shown that advanced nuclear power plants should weigh on the order of 25 to 35 lb/kW for systems of about 2000°F maximum temperature and 250 kW to 3 MW power output. Propulsion times range from about 5000 to more than 30,000 hr, depending upon the mission. Lower specific power plant weight (less than 30 lb/kW) has only a slight effect in reducing power plant life requirements. In terms of maximum flexibility and multimission capability, the most attractive system is a 90,000-lb spacecraft with 1 MW of power to the engines. This vehicle is boosted to earth escape velocity by Saturn V. Other favorable combinations of power plant and spacecraft are obtained with ratings as low as 250 kW, by boosting beyond escape velocity to achieve minimum propulsion time. (auth)

7876 NUCLEAR-ELECTRIC POWER REQUIREMENTS FOR ELECTRIC ROCKETS. Toms, Ronald S. H. (Electro-Optical Systems, Inc., Pasadena, Calif.); Buhler, Rolf D.; Brewer, George R.; Jahn, Robert G.; John, Richard R.; Stearns, John W. Progr. Astronaut. Aeronaut., 16: 229-59(1966).

From 3rd Biennial Aerospace Power Systems Conference, Philadelphia, Sept. 1–4, 1964. See CONF-640901.

The work of many contributors in describing the nature of the load that will be seen by a nuclear-electric power supply when it is integrated, with an electric thruster system, into a nuclear-electric rocket as primary propulsion for space missions is summarized. The competitive position of electric rockets depends on the achievement of adequate lifetimes and low weight for each of its components, including the power conditioning system. Mission studies generally show the electric rocket to be attractive for several important future missions, providing the total rocket weight is less than about 30 lb for each kilowatt of power converted to directed kinetic energy in the exhaust. Specific impulse values needed range from about 3500 to 8000 sec, depending on the optimizing criteria used, and will increase as rocket specific weight becomes reduced. Chief current candidate thruster types are described, with emphasis on the arcjet, the contact ion engine, the bombardment ion engine, and the pulsed plasma engine. The conditioning of power to supply the requirements of a single thruster, or a cluster of similar thrusters, is described. The acceptability of supply ripple and of slow and rapid transients in the supply is discussed. The dynamic behavior of the loads represented by contact and bombardment ion engines is described. The simplification to power systems offered by new developments in high-impulse arcjets is discussed. (auth)

7877 AUXILIARY POWER GENERATING SYSTEM FOR A LARGE SPACE LABORATORY. Tonelli, A. D.; Secord, T. C. (Douglas Aircraft Co., Inc., Santa Monica, Calif.). Contract NAS-9-1688. Progr. Astronaut. Aeronaut., 16: 299-322(1966).

From 3rd Biennial Aerospace Power Systems Conference, Philadelphia, Sept. 1–4, 1964. See CONF-640901.

The results of a study of auxiliary power generating systems for a large 24-man space laboratory for the post-1970 time period are presented. Solar dynamic, nuclear Snap 8, and solar cell-battery units were investigated as possible auxiliary power systems capable of generating 18 to 40 kW of electrical power. Trade offs in weight, cost, reliability, solar area deployed and/or radiator area were performed for the various systems. The power required for subsystem operation and experimentation was established at 27 kW. On the basis of the trade offs and the 27 kW design load, the solar dynamic Brayton system was recommended for the laboratory. (auth)

7878 PRELIMINARY STUDY OF THERMAL INTEGRATION OF ELECTRICAL POWER AND LIFE SUPPORT SYSTEMS FOR MANNED SPACE VEHICLES. Hanson, Kenneth L. (General Electric Co., Philadelphia). Progr. Astronaut. Aeronaut., 16: 361-73(1966).

From 3rd Biennial Aerospace Power Systems Conference, Philadelphia, Sept. 1–4, 1964. See CONF-640901.

Life support systems for current manned missions consume material at a higher rate, typically 21 lb/man-day, than can be tolerated for long-term missions of the future; thus development of closed life support systems is underway. It appears desirable to utilize heat from thermal to electrical power systems in life support endothermic processes rather than electrical heating in order to reduce the total electrical power requirements. Consideration of waste water and urine treatment, and recovery of O_2 from CO_2 processes shows it is feasible to provide approximately 50% of the life support power requirement with heat from solar, isctope, and reactor dynamic power systems. For early capability manned orbiting systems, the life support power requirements are typically 50% of the total power requirement, so that thermal integration reduces the electrical power load approximately 25%. This is a significant reduction in such critical items as collector and radiator area and isotope inventory. For later, larger stations and manned interplanetary vehicles the life support power requirements will be a small fraction of the total electrical power requirement and there will be less incentive for thermal integration. (auth)

7879 SNAP 2, 8, AND 10A REACTOR PROGRAMS PROGRESS REPORT. Cockeram, D. J. (Atomics International, Canoga Park, Calif.). Contract AT(11-1)-Gen-8. Progr. Astronaut. Aeronaut., 16: 393-415(1966).

From 3rd Biennial Aerospace Power Systems Conference, Philadelphia, Sept. 1–4, 1964. See CONF-640901.

The SNAP 2/10A and SNAP 8 reactors form the basis of a family which can be coupled with thermoelectric or mercury-Rankine power conversion systems for space applications. Configurations and systems applications of these reactors are reviewed, the advances reported, and the growth potentials discussed. The S2/10A reactor program has evolved into two separate design generations, the S10A and the S10A/2, to meet the respective needs of the S10A and the S2 systems programs, which are projected toward unmanned space applications. High confidence is placed in the reliability of S10A in orbital operation. Conceptual studies have been initiated of an advanced S10A reactor which will provide longer range capability and higher performance. The SNAP 8 reactor is projected for use in manned space applications. The SNAP 8 Experimental Reactor has been in operation for greater than one year and has demonstrated control of hydrogen leakage from the fuel elements at 1300°F operation. Analyses of control drum worths, critical mass, and temperature coefficients of reactivity have been verified. The SNAP 8 Developmental System reactor will be subjected to nuclear tests. (auth)

7880 APPLICATION OF THE BRAYTON CYCLE TO NUCLEAR ELECTRIC SPACE POWER SYSTEMS. Coombs, M. G.; Norman, L. W. (AiResearch Mfg. Co., Los Angeles). Progr. Astronaut. Aeronaut., 16: 419-81(1966).

From 3rd Biennial Aerospace Power Systems Conference, Philadelphia, Sept. 1–4, 1964. See CONF-640901.

The characteristics of the closed recuperated Brayton cycle power conversion system are discussed, and parametric performance data are presented over a spectrum of operating temperatures and power levels. Conceptual designs of isotope and reactor systems employing Brayton cycle power conversion systems are presented. A status report on current developments and progress over the last year on Brayton cycle hardware is given. (auth)

7881 STATUS OF SNAP-8 ELECTRICAL GENERATING SYSTEM. Powell, R. W. (Aerojet-General Corp., Azusa, Calif.). Progr. Astronaut. Aeronaut., 16: 483-502(1966).

From 3rd Biennial Aerospace Power Systems Conference, Philadelphia, Sept. 1–4, 1964. See CONF-640901.

The SNAP-8 is a 35-kW turboelectric nuclear space power system using a mercury Rankine cycle. It will operate continuously for 10,000 hr after remote automatic startup. Possible applications for SNAP-8 include manned space stations, manned lunar bases, and deep space probes. The unique features of the four-loop system are described. A brief report is given on the status of the program including the Nuclear Reactor System. The facilities for nonnuclear and nuclear testing of the power conversion system are described. The developmental design features and the confirming test data are presented on the following significant components of the power conversion system: the boiler, the condenser, the auxiliary start loop heat exchanger, the turbine-alternator assembly, the composite seal to space, the Hg motor pump assembly, the NaK motor pump assemblies, and the lubricant-coolant pump assembly. A $\frac{1}{16}$ scale four-loop corrosion loop system which is being operated concurrently with the SNAP-8 program will be described. Extrapolation of this data is expected to yield performance data on the mercury containment materials ability to survive the 10,000 hr space requirement. The results of the nuclear radiation tests on materials and components are discussed. (auth)

7882 MPRE: A BOILING POTASSIUM REACTOR SYSTEM. Fraas, Arthur P. (Oak Ridge National Lab., Tenn.). Progr. Astronaut. Aeronaut., 16: 525-40(1966).

From 3rd Biennial Aerospace Power Systems Conference, Philadelphia, Sept. 1–4, 1964. See CONF-640901.

A study carried out in 1958 indicated that, for a given peak system temperature, a Rankine vapor cycle employing either K or Rb vapor should give the minimum size and weight of the radiator and other major components for turbine-generator nuclear space power plants. Reliability studies indicated that only by going to the simplest possible system could we hope to achieve the desired reliability. Preliminary system layouts showed that a single-fluid system with the reactor serving as the boiler minimizes the number of components. Further, by eliminating the temperature losses associated with a primary fluid circuit and an intermediate heat exchanger, the single fluid system reduces the peak metal temperature required for a given vapor temperature at the turbine inlet by 200 to 300°F, and makes possible a system weight of about 25 lb/kW(e) for a stainless steel system with K boiling in the reactor at about 1500°F. A reference design for a launch package has been prepared to serve as the basis for the design of the K system of the reactor experiment. These two systems are compared, and some of their problems—including meteoroid protection and two-phase flow in the condenser—are discussed. (auth)

7883 SNAP-50/SPUR PROGRAM. Douthett, Elwood M. (Atomic Energy Commission, Washington, D. C.). Progr. Astronaut. Aeronaut., 16: 541-60(1966).

From 3rd Biennial Aerospace Power Systems Conference, Philadelphia, Sept. 1–4, 1964. See CONF-640901.

The concept behind the SNAP-50/SPUR nuclear-electric space power plant is presented and the present status of the program is reviewed. It is found that a suitable technological base already exists from which an orderly program can proceed initially to feasibility demonstrations of the reactor and power conversion components and ultimately to a demonstration of an experimental power plant. Nuclear-electric power plants based upon this technology can have a variety of applications in the national space program beyond 1975. (auth)

7884 SUMMARY OF THE SNAP MERCURY RANKINE SYSTEM STATUS. Wallerstedt, R. L. (Atomics International, Canoga Park, Calif.); Ono, G. Y. Progr. Astronaut. Aeronaut., 16: 561-9(1966).

From 3rd Biennial Aerospace Power Systems Conference, Philadelphia, Sept. 1–4, 1964. See CONF-640901.

The development of the SNAP Mercury Rankine nuclear power plant system is summarized from its inception in 1957 to September 1964. The current power plant discussed provides a 3- to 20-kW(e) capability utilizing components now under full development. The technical considerations and problem areas associated with the Mercury Rankine System components are discussed. The expansion of this system to greater power capabilities is also described. (auth)

7885 SNAP 10A: A STATUS REPORT. Wilson, R. F. (North American Aviation, Inc., Canoga Park, Calif.). Contract AT(11-1)-Gen-8. Progr. Astronaut. Aeronaut., 16: 581-93(1966).

From 3rd Biennial Aerospace Power Systems Conference, Philadelphia, Sept. 1–4, 1964. See CONF-640901.

The SNAP 10A is a nominal 500-W electric space power station employing a nuclear reactor heat source and thermoelectric power conversion equipment. The principal technical objectives established upon the initiation of the program, and still current, are as follows: (1) production of a minimum of 500 W, at 28.5 V dc, over a period of one year within the space environment; (2) provision of shielding capable of attenuating radiation to approximately 5×10^{12} nvt of fast neutrons and 4×10^{7} R of gammas at the NPU-Agena vehicle mating plane; (3) capability of remote startup in orbit by ground command; (4) capability of handling, transport, and launch within acceptable safety criteria and without incurring extensive modifications to normal launch base and checkout procedures; (5) after initial startup period, no need for dynamic control or mechanical moving parts throughout its life; and (6) provision of sufficient on-board instrumentation to fully monitor the system during operation in orbit. (auth)

7886 MULTIPLE-STAGE THERMIONIC MODULE. Eastman, G. Y.; Hall, W. B. (Radio Corp. of America, Lancaster, Pa.). Contract AF33(657)-8005. Progr. Astronaut. Aeronaut., 16: 597-603(1966).

From 3rd Biennial Aerospace Power Systems Conference, Philadelphia, Sept. 1–4, 1964. See CONF-640901.

The effort described was directed toward the development of a multi-converter thermionic module for operation from a common heat source and employing a single Cs reservoir for all converters. The problems that were solved included thermally bonding, but electrically insulating, the emitters of the individual converters from the common heat source tubing. In addition, unwanted, low voltage arcs were eliminated and rational addition of the converter voltages was obtained. Success was demonstrated by a life test, with constant performance in excess of design characteristics, of over 4400 hours. (auth)

7887 ENGINEERING EVALUATION OF ADVANCED NUCLEAR THERMIONIC SPACE POWERPLANTS. Bolan, P.; Cohen, R.; Bordner, G. (Pratt and Whitney Aircraft, East Hartford, Conn.). Contract NASw-360. Progr. Astronaut. Aeronaut., 16: 605-25(1966).

From 3rd Biennial Aerospace Power Systems Conference, Philadelphia, Sept. 1–4, 1964. See CONF-640901.

A 1 MW(e) in-pile nuclear thermionic power plant has been studied to determine the potential of this type of power plant and to discover and define technical problem areas and uncertainties. A power plant examination of this type requires an iterative process involving parametric studies and preliminary designs. Initial results usually produce a vague indication of the power system potential and an indication of some of the major uncertainties. Successive iterations produce a refined design and a realistic indication of the future potential and the technical problems and uncertainties of the concept. Initial study of a 1 MW(e) in-pile nuclear thermionic space power system indicated a specific weight potential of 2.4 lb/kW. As the preliminary design was refined to include practical converter dimensions, nonuniform emitter temperature effects, nonuniform reactor power distribution, power-conditioning equipment, launch vehicle integration, and detailed component and structure design, the specific weight increased to 25.6 lb/kW. (auth)

7888 THERMIONIC DOUBLE-DIODE FUELED CONVERTER. Psarouthakis, J.; Long, J. D.; Scicchitano, E. (Martin Co., Baltimore). Contract AF33(675)-10077. Progr. Astronaut. Aeronaut., 16: 627-52(1966).

From 3rd Biennial Aerospace Power Systems Conference, Philadelphia, Sept. 1–4, 1964. See CONF-640901.

Results of an extensive Martin-sponsored research and development program were used to evolve the design of a double-diode thermionic module for out-of-pile testing. Three double-diode thermionic converters, each consisting of two diodes of cylindrical configuration connected electrically in series within a single sheath and utilizing a common cesium reservoir, have been fabricated and tested to evaluate design criteria of a multi-diode converter element. Two of these double-diodes were built with emitters consisting of a UO_2–Mo cermet clad with Mo–½% Ti, and provisions were made for electrical heating. These two modules were tested for periods of 330 and 715 hours, respectively, at emitter temperatures between 1500 and 2000°C. At the termination of each test, the diodes were disassembled, sectioned, and examined to determine the thermal stability of the fuel and components. The third double-diode, unfueled, but of similar geometry and with a solid Mo–½% Ti emitter, has accumulated over 2000 hours of life tests at emitter temperatures between 1500 and 2100°C. Each diode had a 17-mil spacing during operation. Power output densities of 1.5 to 6 W/cm^2 have been produced. An improved thermionic double diode for out-of-pile testing, but with in-pile configuration, has been designed from the above experience. (auth)

7889 LIQUID-METAL MHD POWER CONVERSION. Elliott, D. G.; Cerini, D. J.; Weinberg, E. (California Inst. of Tech., Pasadena). Contract NAS-7-100. Progr. Astronaut. Aeronaut., 16: 1275-98(1966).

From 3rd Biennial Aerospace Power Systems Conference, Philadelphia, Sept. 1–4, 1964. See CONF-640901.

The liquid-metal magnetohydrodynamic (MHD) power plant is a nonrotating system usable with liquid-metal cooled reactors. In this system, a liquid metal is accelerated by vapor in a two-phase nozzle, extracted from the vapor in a high-velocity separator, decelerated by the production of electric power in an MHD generator, and returned through a diffuser to the nozzle via the reactor. The vapor is condensed in the radiator and pumped back to the nozzle. In the experimental investigation, nozzle, separator, and diffuser tests were performed with water and nitrogen, and generator tests were performed with NaK. The nozzle delivered 90% of isentropic exit velocity, the separator achieved about 1% liquid loss and 20% velocity loss, the diffuser had about 75% efficiency, and the generator operated at about 50% efficiency. Extrapolation of the results to a 2000°F space power plant indicated that an unshielded specific weight of 30 to 45 lb/kW is attainable. Lifetime limitations due to erosion and insulator loss were investigated in water-flow and lithium capsule tests, and results indicated negligible material loss up to at least 1000 hr. (auth)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 6517, 6586, and 6676.

7890 (AECL-2778) LATTICE MEASUREMENTS WITH 19-ELEMENT RODS OF ThO_2–$^{235}UO_2$ IN HEAVY WATER MODERATOR. PART I. BUCKLING, FINE STRUCTURE, AND NEUTRON SPECTRUM PARAMETERS. Okazaki, A.; Durrani, S. A. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Oct. 1967. 47p. Dep. CFSTI. CAN $1.50.

Lattice parameters were measured for heavy-water-moderated lattices of 19-element clusters of ThO_2 containing 1.5 wt % enriched UO_2 (93 at. % ^{235}U). Bucklings were determined from critical substitution measurements in the ZED-2 reactor using MICRETE, a two-group heterogeneous reactor code. Neutron density distributions and Westcott spectrum parameters r and T were obtained from measured ^{56}Mn, ^{116}In, and ^{177}Lu activities in foil detectors. Measurements were made for D_2O, air, H_2O and HB-40 coolants and for 22, 24, 28, and 32 cm triangular lattice pitches. (auth)

7891 (BNWL-611) PRELIMINARY SAFETY STUDIES FOR THE NPTF. Waltar, A. E.; Harris, R. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1967. Contract AT(45-1)-1830. 74p. Dep. CFSTI.

Hypothetical accidents in the Nuclear Proof Test Facility

(NPTF) are described and analyzed. The three areas discussed include: initiating mechanisms; meltdown; and disassembly. Using the initiating mechanisms of a face closing accident in the NPTF, a fuel rod drop, and a control rod drop, the ramp rates were determined for meltdown calculations. Comparisons of core meltdown analysis using MELT-1 computer code and NUTIGER coupled heat transfer kinetics code are presented. The Doppler effects during meltdown are determined. The core disassembly phase is analyzed for the NPTF, and the effects of Doppler coefficient and ramp rate on the energy release are described. (D.C.C.)

7892 (DPST-67-83-10) USAEC-AECL COOPERATIVE PROGRAM MONTHLY PROGRESS REPORT, OCTOBER 1967. Rusche, B. C. (Du Pont de Nemours (E.I.) and Co., Aiken, S. C. Savannah River Lab.). Nov. 30, 1967. Contract AT(07-2)-1. 5p.

Comparisons of values of η obtained from HAMMER calculations for ^{235}U and ^{233}U and experimentally obtained values are made. Physics parameters for $(1/\eta)$ $(d\eta/dT)$ lattices are tabulated. Effects of temperature variation are outlined. (M.L.S.)

7893 (GA-7319) EBOR CONTROL ROD DRIVE DEVELOPMENT PROGRAM: A SECOND INTERIM REPORT. Anderson, J. K. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Nov. 1966. Contract AT(04-3)-187. 81p. Dep. CFSTI.

Design alternatives and the basis for major design decisions are presented for EBOR control rod drive mechanism for long term operation at high temperature in He. Engineering flow sheets graphically show the tasks which comprise the overall program and how these tasks relate to each other and to the Phase I operations at the site. (auth)

7894 (GA-8191) FAST REACTOR SPECTRUM MEASUREMENTS. Quarterly Progress Report for the Period Ending July 31, 1967. Preskitt, C. A.; Stevens, C. A. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Aug. 17, 1967. Contract AT(04-3)-167. 31p. Dep. CFSTI.

A description of the Subcritical Time-of-Flight Spectrum Facility (STSF) is given. General operation of the facility is discussed. The associated fuel storage and handling facility is described. Results of calculations for homogeneous systems are shown. Fast neutron spectra calculations are shown for various positions from the source. 9 references. (M.L.S.)

7895 (INR-779/XIV/PS) WLASNOSCI STOPU PAR-1 PRZEZNACZONEGO NA ELEMENTY KONSTRUKCYJNE RDZENIA REAKTORA EWA 10. (The Properties of PAR-1 Alloy for the Construction of the Core of Nuclear Reactor EWA 10 MW). Bochenek, B.; Szulc, L. (Institute of Nuclear Research, Warsaw (Poland)). 1967. 37p. (In Polish). Dep.

The results of analysis and investigations of the physical, mechanical and nuclear properties of the wrought elements of PAR-1 alloy, for the EWA 10 MW reactor core, are described. The possibility of the use this alloy in the constructions of nuclear reactors has been confirmed. (auth)

7896 (INT/SPR-65-699) REFONTE DU COMPARTIMENT AVANT DE MELUSINE. SURVEILLANCE ET MESURES DE RADIOPROTECTION PENDANT LES TRAVAUX DE DEMONTAGE. (Remodeling of Compartments of Melusine. Surveillance and Measurements for Radioprotection During Disassembly). Bosc, P.; Delpuech, J.; Tibaud, C. (Commissariat a l'Energie Atomique, Grenoble (France. Centre d'Etudes Nucleaires). July 1965. 24p. (In French). Dep.

In the remodeling of Melusine compartments the withdrawal and storage of inpile and core lattice experiments, discharge of the core and removal of the fuel elements, draining of three compartments of the swimming pool, disassembly of the channels, removal of the araldite, decontamination of the forward and mid compartments, and personnel control are described. The results of radiation measurements from each of these procedures are reported in graphic form and discussed in some detail. (J.S.R.)

7897 (LA-DC-9110) DAMAGE FLUX IN CRITICAL ASSEMBLIES. Anderson, Richard C. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 15p. (CONF-671045-1). Dep. CFSTI.

From IEEE Thermionic Conversion Specialist Conference, Palo Alto, Calif.

An important limitation on the design of an in-pile thermionic reactor is the fast neutron irradiation damage to the insulators, which is expressed quantitatively by the energy weighted neutron flux, or damage flux. The behavior of the damage flux has been investigated for a set of hypothetical critical assemblies containing different types of fuel and different amounts of moderator. It is shown that for a given fuel, the damage flux is reduced by moderating the neutron spectrum, and for a given amount of moderator the damage flux is reduced by increasing the amount of fuel in the fuel pin. Some effects of damage flux considerations on reactor design are also shown. (auth)

7898 (NP-17064) RAYONNEMENT γ DU MUR DE PLOMB ET DE LA GRILLE DE SILOETTE. (γ Activity in Lead Shielding and the Silo Containment). Rouat, L. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). May 26, 1965. 4p. (In French). Dep.

Gamma radiation measurements were made at contact with the lead shield for the Siloette reactor. Measurements were also made in the pool water. Safety precautions for installation of an in-core liquid hydrogen loop were then determined. Numerical results are tabulated. (M.L.S.)

7899 (ORNL-TM-1904) HFIR FUEL ELEMENT STEADY STATE HEAT TRANSFER ANALYSIS. REVISED VERSION. McLain, Howard A. (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 204p. Dep. CFSTI.

The steady state heat transfer analysis of the HFIR fuel elements was completely rewritten using new information regarding the thermal deflections of the fuel plates. This analysis uses an integral thermal-hydraulic model which simultaneously accounts for the nuclear, hydraulic, heat transfer, mechanical, and the corrosion history of the operating reactor. It shows that the design requirements for the HFIR fuel elements have been met. Imposing the criteria of no boiling in the fuel elements, the upper limit for the power at startup is 139 Mw and that at the end of a 25 day 100 Mw fuel cycle is 153 Mw. (auth)

7900 (ORNL-TM-1960) OPERATION OF MOLTEN-SALT CONVECTION LOOPS IN THE ORR. Savage, H. C.; Compere, E. L.; Baker, J. M.; Bohlmann, E. G. (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 35p. Dep. CFSTI.

Two molten-salt convection loops have been operated in beam hole HN-1 of the Oak Ridge Research Reactor. Both loops contained molten-fluoride fuel salt with enriched U varying in concentration up to 2.1 mole %. Irradiation of the first molten-salt convection loop experiment in the ORR was terminated on August 8, 1966, after 1484 hr of in-pile operation and development of 1.1×10^{18} fissions/cc. Average fuel power densities up to 105 w/cc of salt were obtained in the fuel channels of the core of MSRE-grade graphite. Irradiation of the second loop experiment in the ORR was terminated on April 4, 1967, after 1955 hr of in-pile operation and development of 8.2×10^{18} fissions/cc. Average fission heat density in the fuel salt channels of the graphite core was 165 w/cc when at full power. Successful operation of the major heating, cooling, temperature control, and sampling systems was demonstrated; however, both loop experiments were terminated because of breaks in the primary loop systems. (auth)

7901 (ANL-Trans-541) CALCULATION OF HETEROGENEOUS EFFECTS IN CRITICAL FAST NEUTRON ASSEMBLIES. Sirotkin, A. M.; Slesarev, I. S.; Troyanov, M. F.; Khromov, V. V.; Yurova, L. N. Translated by Elmar K. Wilip (Argonne National Lab., Ill.), from Paper Presented at Symposium on Fast Reactor Physics and Related Safety Problems, Karlsruhe, Germany, October 30-November 3, 1967. 20p. (CONF-671043-12). Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

The developed calculational method permits the investigation of heterogenous effects to be estimated in critical assemblies with a consideration of the two-dimensionality, of the difference in the composition of the zones, and of the non-periodicity of the arrangement of the single cells. The method uses the multigroup approach and high approximations in the solution of the kinetic equation of the neutron transfer. A verification of the method by means of a comparison of the calculated heterogeneity effects with the experimental data showed its good accuracy. The application of the proposed method for the investigation of the critical assemblies BFS-8 and BFS-16 permitted the part played by heterogenous effects in these assemblies to be clarified. (tr-auth)

7902 (JPRS-43049) CRITICAL ASSEMBLY FOR STUDYING "PURE" URANIUM-WATER LATTICES. Krasin, A. K.; Danilevich, L. A.; Levandy, V. A.; Nosau, G. A.; Sapozhnikau, U. U.; Churkin, Yu. I.; Yarashevich, A. I. Translated from Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 4, 12-16(1966). 9p. (TT-67-33674). CFSTI.

A description of the critical assembly "Roza" is given. The physics of nuclear reactors, some physical characteristics of the critical assembly, and a brief description of the control and emergency-protection system of the physical stand are presented. (tr-auth)

7903 PULSE PROPAGATION EXPERIMENT UPON HETEROGENEOUS MULTIPLYING SUBCRITICAL ASSEMBLIES AS A

CORRELATION TOOL. Barrett, P. R. (Univ. of New South Wales, Australia). Nucl. Eng., 12: 764-6(Oct. 1967).

The propagation of a thermal neutron wave through a bare, multiplying, heterogeneous, subcritical assembly of fuel and moderator is examined. Homogenizing the assembly by a cell reaction rate conservation method results in a frequency-dependent phase lag between the spatially averaged fuel and moderator zone fluxes in a lattice cell. The dispersion law for wave propagation in a heterogeneous medium is used to show how the pulse propagation method can be employed to determine relationships between the parameters of the system, and how these can be utilized in a correlation between theory and experiment. (auth)

7904 IRRADIATION APPARATUS. Bret, Antoine; Robert, Roger; Touchet, Roland (to Commissariat a l'Energie Atomique). British Patent 1,094,290. Dec. 6, 1967. Priority date Apr. 30, 1965, France.

The design of a controlled-temperature irradiation apparatus for nuclear reactors is presented. An irradiation tube containing the specimens is kept at a constant temperature inside a furnace and the temperature of the specimens is constantly monitored. This apparatus is designed for convenient assembly and dismantling. (W.H.K.)

7905 SIPHON BREAKER FOR A NUCLEAR REACTOR. Yoshiyanagi, Kiyomi (to Hitachi Ltd.). Japanese Patent 1966-20520. Nov. 30, 1966. Filed Dec. 17, 1962.

An improved siphon breaker is proposed for the swimming-pool type reactor in which coolant is circulated through the reactor core, an external heat-exchanger, and back into the core. The piping for circulating coolant water starts from the bottom of the reactor core, goes up within the pool water, penetrates the wall of the water pool in the upper part, comes down along the outside of the wall, goes through the pump and heat-exchanger, goes up again, bends towards the pool at about the same height as the penetration, and finally goes into the core tank. Within the pool water an upright pipe which opens to the atmosphere connects the horizontal parts of the piping, both where the piping comes out of and goes into the water pool. (NSA of Japan)

7906 METHOD OF NEUTRON-SPECTRUM SHIFT, USING A GAP IN FUEL CHANNELS. Matsuhara, Takeo (to Sumitomo Electric Ind., Ltd.). Japanese Patent 1966-20918. Dec. 6, 1966. Filed Nov. 15, 1963.

The advantages to the proposed method are elimination of a D_2O concentration equipment, control of a local neutron spectrum, increase in the fuel burnup, and possibility of fuel breeding. Each fuel channel has the inner tube (in which fuel rods are packed) and the outer tube; moderator flows through the space between the two tubes. Heavy water is pumped through all the fuel channels until fuel burnup progresses. Light water is then pumped through some of the fuel channels, and gradually increased until the light water is flowing through all the fuel channels. (NSA of Japan)

Reactor Theory, Components, Fuels, and Accessories

Refer also to abstracts 6527, 6678, 6954, 7048, 7054, 7069, 7072, 7616, 7619, 7626, 7627, 7705, and 7983.

7907 (ABS-THH-1040) TABELLEN DER TOTALEN GAMMA-SCHWAECHUNGSKOEFFIZIENTEN DER ELEMENTE 0,01 MeV–100 MeV. (Tables of Total Gamma Attenuation Coefficients of the Elements at 0,01 MeV to 100 MeV). Sasse, S. (Technische Hochschule, Hanover (West Germany). Arbeitsgruppe fuer Bautechnischen Strahlenschutz). July 1967. 28p. (In German). Dep.

The total γ attenuation coefficients were extrapolated from the values for 22 elements experimentally determined by Hubbell and Berger. The results are tabulated. (J.S.R.)

7908 (ANL-7304) PERC, A TWO-DIMENSIONAL PERTURBATION CODE BASED ON DIFFUSION THEORY. Leaf, G. K.; Kennedy, A. S. (Argonne National Lab., Ill.). May 1967. Contract W-31-109-eng-38. 72p. Dep. CFSTI.

A mathematical formulation for PERC, a two-dimensional diffusion theory perturbation code, is derived. The code estimates changes in k_{eff} due to changes in the reactor system. Computer program usage and machine requirements are discussed. A sample problem is given. 8 references. (M.L.S.)

7909 (JINR-P4-3580) VYRAVNIVANIE POTOKA V GETEROGENNOM REAKTORE. (Flux Flattening in a Heterogeneous Reactor). Lelek, V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 13p. (In Russian). Dep.

The problem of determining rod coordinates of the same type in such a way that the thermal flux on the rods is flattened is solved. It turns out that the lattice for the reactor with more than 20 rods can be precisely calculated by the homogenous method. (auth)

7910 (JINR-P4-3581) VYRAVNIVANIE POTOKA V REAKTORE PRI POMOSHCHI NERAVNOMERNOGO RASPREDELENIYA GORYUCHEGO S UCHETOM REZONANSNOGO ZAKHVATA. (Flux Flattening in a Reactor by Means of Non-Uniform Fuel Distribution With the Account of Resonance Capture). Lelek, V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 14p. (In Russian). Dep.

Dependence of the critical size and fuel concentration upon the dimension of the reflector is shown for the reactor with flattened flux. The space dependence of the resonance capture ρ is taken into account. The dependence of ρ upon the fuel concentration leads to the existence of a certain minimum thickness of the reflector within which the requirement of the flattened flux can be fulfilled. The critical size of the active zone tends to infinity, when the reflector thickness tends to minimum one. The power density of the reactor with flattened flux is in the limit of the infinitive dimensions 0.435^{-1} larger for the cylindrical geometry than for the reactor with the constant fuel distribution. (auth)

7911 (KAPL-P-3389) ANALYTIC SOLUTION OF THE TIME LINEARIZED KINETIC EQUATIONS OF MULTIREGION REACTORS. PART 1. THEORY AND ITS APPLICATION TO ONE-DIMENSIONAL REACTOR MODELS. Bobone, Renato (Knolls Atomic Power Lab., Schenectady, N. Y.). July 31, 1967. Contract W-31-109-eng-52. 23p. (CONF-671102-24). Dep. CFSTI.

From 15th Conference on Remote Systems Technology and Atom Fair, Chicago, Ill.

A method for analytic solution to the space-time kinetics equations in the diffusion approximation for a multiregion reactor is presented. The space-time equations are linearized with respect to time resulting in a single space differential equation. The linearization is accomplished by a linear combination of degenerate eigenfunctions of Helmholtz' equation which is used to represent the flux. A computer program can then obtain a discrete truncated series of orthogonal solutions which represent the flux in any given region. This allows diffusion equations to be solved to any desired degree of approximation. 12 references. (M.L.S.)

7912 (LA-3740) THE DATA OF NUCLEAR REACTOR PHYSICS. A Bibliography. Furnish, Jean (comp.) (Los Alamos Scientific Lab., N. Mex.). Apr. 13, 1967. Contract W-7405-eng-36. 182p. Dep. CFSTI.

A bibliography on reactor physics is presented. The abstracts cover the period from 1956 to 1 March 1967. These abstracts are grouped as follows: critical experiments, reasonably homogeneous; critical experiments, lattices; neutron group averaged cross sections; reactivity measurements for component materials; and Doppler effects on reactivity. The abstracts are arranged chronologically, according to group. (M.L.S.)

7913 (LA-3791) COATED PARTICLE FUELS: THERMAL, MECHANICAL, AND STRESS PROPERTIES. A Bibliography. Furnish, Jean (comp.) (Los Alamos Scientific Lab., N. Mex.). Aug. 15, 1967. Contract W-7405-eng-36. 20p. Dep. CFSTI.

A bibliography on coated particle fuels from 1964–1967 is presented. Mechanical and thermal properties of uranium materials are the primary area of interest; interaction of the fuels with their matrix is also considered. (M.L.S.)

7914 (LA-DC-9092) DEVELOPMENT OF THE S_n DISCRETE ORDINATES METHOD. Carlson, Bengt G. (Los Alamos Scientific Lab., N. Mex.). Sept. 14, 1967. Contract W-7405-eng-36. 23p. Dep. CFSTI.

The formulation of an S_n discrete ordinates method for solution to neutron transport equations is presented. Almost connected line segments are used to approximate neutron flux as a function of space. A comparison of various values of quadrature sets, which have been obtained by discrete S_2, Gauss–Legendre quadrature, and S_n discrete ordinates methods, are given. (M.L.S.)

7915 (NUCLEX-66) FABRIKATION DES REAKTOR-RUCKGEFAESSE. ([Reactor Pressure Vessel Fabrication]). (Skoda Works, Pilsen (Czechoslovakia)). [nd]. 56p. (In German). Dep.

Separate abstracts were prepared for each of the four papers which briefly describe research on optimum shapes for large pressure vessels, heat treatment for thick-walled vessels, and

fabrication and welding procedures for the vessel of the first Czechoslovakian nuclear power station. (H.D.R.)

For abstracts of individual papers see: 7811, 7812, 7916, and 7917.

7916 (NUCLEX-66, Paper 1) BEITRAG ZU DEN FESTIGKEITSPROBLEMEN GROSSER REAKTOR-DRUCKGEFAESSE. (Report on the Strength Problems of Large Reactor Pressure Vessels). Stepanek, Stanislav (Skoda Works, Pilsen (Czechoslovakia)). 13p. (In German).

A procedure and results of works concerning the research of optimum shapes for nuclear reactor pressure vessels from the standpoint of strength, as well as the protection against possibility of occurrence of brittle fracture are briefly discussed. (auth)

7917 (NUCLEX-66, Paper 2) BEITRAG ZU DEN MATERIALEIGENSCHAFTEN DES TSECHOSLOWAKISCHEN DICKWANDINGEN REAKTORDRUCKGEFAESSES. (Report on the Material Properties of Czechoslovakian Thick-Walled Reactor Pressure Vessels). Beran, Jaroslav (Skoda Works, Pilsen (Czechoslovakia)). 12p. (In German).

The introduction of special heat treatment of the pressure vessel parts, based on completing the current annealing processes by annealing in the $\alpha-\gamma$ region, has enabled the SKODA to deliver the reactor pressure vessel with very good values of strength and toughness in the thickest areas together with excellent isotropy of mechanical properties. (auth)

7918 (ORNL-NDIC-2) ABSTRACTING AND INDEXING GUIDE FOR THE NUCLEAR DESALINATION INFORMATION CENTER. Johnsson, K. O. (Oak Ridge National Lab., Tenn.). Dec. 1967. Contract W-7405-eng-26. 30p. Dep. CFSTI.

A guide is given for Nuclear Desalination Program personnel to aid in their preparation of report abstracts and selection of descriptive keywords covering the content of the reports. The abstracts and keywords will be used in a computer-based storage and retrieval system by the Nuclear Desalination Information Center at the Oak Ridge National Laboratory. The Guide gives suggestions on the type of abstract needed and factors to consider when selecting keywords; it includes a thesaurus of about 600 keywords in the format used by the Engineers Joint Council. A sample computer output of abstracts in the system is included. (auth)

7919 (ORNL-P-2033) MULTIPLICATION FACTOR OF URANIUM METAL BY ONE-VELOCITY MONTE CARLO CALCULATIONS. Mihalczo, John T. (Oak Ridge National Lab., Tenn.). [1965]. Contract W-7405-eng-26. 20p. Dep. CFSTI.

A method is describef for predicting the neutron multiplication factors of geometrically complicated configurations of unreflected unmoderated enriched U metal from the results of two delayed-critical experiments in simple geometry, one with a nearly minimum surface-to-volume ratio and the other with a large surface-to-volume ratio. The method requires two constants characteristic of the U. These are the total collision cross section (Σ_t) and the number of neutrons produced per collision ($\nu\Sigma_f/\Sigma_t$), which are obtained from the two experiments by using S_{12} transport theory calculations with isotropic scattering. These factors, together with the assumption of isotropic scattering, are then used in O5R Monte Carlo neutron transport calculations to predict the multiplication factors. The method has been tested by predicting the multiplication factors of 21 different delayed-critical configurations to within a standard deviation of 1.5%. (auth)

7920 (ANL-Trans-540) INVESTIGATION OF THE DOPPLER EFFECT IN ^{238}U IN A SHIELD MADE OF URANIUM OXIDE OF THE REACTOR BR-1. Abagyan, L. P.; Golubev, V. I.; Golyaev, N. D.; Zvonarev, A. V.; Koleganov, Yu. F.; Nikolaev, M. N.; Orlov, M. Yu. Translated from a paper presented at the IAEA Symposium on the Physics and Safety Problems of Fast Reactors, Karlsruhe, German Federal Republic, October 30-November 3, 1967. 14p. (CONF-671043-13). Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

The Doppler effect in ^{238}U is studied by measuring the temperature increments of the effective resonance integral of absorption of thin ^{238}U-oxide sample placed in a large block of UO_2. The Doppler increment of the rate of reaction was measured from 300 to 2000°K. (D.C.C.)

7921 TRAINING SIMULATOR AT BERKELEY. Nucl. Eng., 12: 773(Oct, 1967).

An outline is given of the capabilities and use of a general purpose analogue computer preprogrammed for reactor simulation of Magnox and AGR systems. It can be operated in the axial mode to demonstrate the temperature distribution in a fuel channel for startups, power running and operation of the reactor with automatic and manual control. Operated modally, it demonstrates interzonal disturbances at various points across a core operating at full power. A number of abnormal conditions can be simulated. (UK)

7922 NUCLEAR SCIENCE AND ENGINEERING ON THE FIFTIETH ANNIVERSARY OF THE GREAT OCTOBER SOCIALIST REVOLUTION. Petros'yants, A. M. At. Energ. (USSR), 23: 379-95(Nov. 1967). (In Russian).

A brief review is given on the achievements of Soviet atomic science and techniques for the last 50 years. The principal goals of the peaceful uses of nuclear energy in USSR industry, agriculture and health sciences are discussed. (R.V.J.)

7923 TWO-DIMENSIONAL FOUR-GROUP CALCULATION BASED ON PARTIAL BUCKLING. Okamoto, Sunao (Kyoto Univ.). Nippon Genshiryoku Gakkaishi, 9: 590-6(1967). (In Japanese).

A polynomial expression is proposed as a method of representing the distribution of neutron flux where the multi-group diffusion equation is machine-computed. A given system is divided into several sections that are fairly large compared with the mesh sizes usually adopted in calculations using difference equations. One reason why the polynomial is useful is that no change is required for its fundamental formation to accord with varying geometric factors such as the shape of the section and buckling of the flux distribution. The treatise presents a two-dimensional analysis, using the polynomial expression and the concept of partial buckling, introduced to substitute boundary conditions calculated from the flux distribution of the system. The potential applications of the analysis based on partial buckling are discussed on the basis of the results of two dimensional calculations on a system having a square cross section, in which the distribution along the X-axis is calculated with a difference equation, and that for the Y-axis is obtained from partial buckling. (auth)

7924 GAMMA-RAY LEAKAGE THROUGH A SLIT IN LEAD SHIELD. I. Miyasaka, Shun-ichi (Japan Atomic Energy Research Inst., Tokyo); Kanemori, Yoshihiko; Fukushima, Yutaka; Yamada, Takeshi Nippon Genshiryoku Gakkaishi, 9: 597-603 (1967). (In Japanese).

Experiments on γ-ray leakage through a slit in lead shield were conducted as part of mock-up tests for shielding to be provided on the first Japanese nuclear propelled ship. The dry shielding test facility in JRR-4 was utilized for the experiments. Experimental results are reported for straight slits, with data covering γ-ray leakage as function of slit width, beam incident angle and of positions of measurement. A semi-empirical method is proposed for estimating the dose rate distribution of the streaming component. (auth)

7925 DETERMINATION OF THE RADIATION FIELD IN NUCLEAR REACTOR SHIELDING ON THE BASIS OF MEASUREMENTS ON A LIMITED PARALLEL BEAM. PART II. MEASURED INTENSITY DISTRIBUTIONS OF NEUTRONS AND GAMMA RADIATION OF A PLANE PARALLEL BEAM AND RELAXATION LENGTHS AS FUNCTIONS OF THE VOLUME PERCENTAGE OF THE METAL COMPONENT IN THE SHIELD. Thuro, G.; Heske, M.; Richter, G.; Schnier, C.; Thuro, I. (Institut fuer Reaktorphysik der GKSS, Geesthacht, Ger.). Atomkernenergie 12: 409-14(1967). (In German).

The relative contributions of thermal, epithermal and fast neutrons and of γ-radiation to the total biological dose rate of a plane monodirectional beam have been found for 30 shield compositions from measurements at a limited monodirectional beam of a nuclear reactor beam-hole. The shields are composed of combinations of water, steel, lead, polyethylene or concrete. From these results the radiation fields in corresponding shields of natural geometry (for example: of a nuclear reactor) can be determined. Relaxation lengths of the 4 mentioned radiation groups in quasi-homogeneous shield compositions of Fe-H_2O, Fe-Polyethylene, Pb-H_2O and Pb-Polyethylene with different volume percentages of the metal component have been found from measured intensity distributions. From this the optimum (i.e. with the best shielding properties) volume percentages $V_{a,opt}$ have been found. For Fe-H_2O-combinations $V_{a,opt} = 68 \pm 5\%$, for Fe-polyethylene 73%, for Pb-H_2O 80% and for Pb-polyethylene $22 \pm 2\%$. (auth)

7926 BURNUP PREDICTIONS FOR THERMAL REACTORS: A SYNTHESIS OF APPROXIMATIONS. Spinrad, Bernard. Reactor Fuel-Process. Technol., 10: 190-8 Summer 1967).

Basic burnup theory including space-time variations, reactivity changes, and approximations necessary for evaluating the basic equations are discussed. The basic theoretical approaches to burnup calculations are outlined. Some specific applications are described. 29 references. (M.L.S.)

7927 VIBRATION OF REACTOR CORE COMPONENTS. Wambsganss, Martin W. Jr. Reactor Fuel-Process. Technol., 10: 208-19(Summer 1967).

Problems associated with high-velocity coolant flow induced reactor core vibration are presented. Vibrational problems in the EBR-II, GETR, Big Rock Point, Yankee, SPERT-III, and MSRE are outlined. Characteristics of the vibrations are summarized. Rod vibration in cross flow and parallel flow is detailed. Flat plate vibrations are discussed. Damping, modeling, and scaling are briefly considered. 54 references. (M.L.S.)

7928 HYDRAULIC CALCULATION OF THE COOLING SYSTEM OF NUCLEAR REACTORS. Kochenov, I. S.; Novosel'skii, O. Yu. At. Energ. (USSR), 23: 113-20(Aug. 1967). (In Russian).

An improved method for the hydraulic calculation of the active zone of a reactor was proposed. The method was made more precise by the introduction of the equation of motion of a variable-mass liquid. This equation describes the flow of the coolant in the reactor collector (chamber). Piezometric lines of the distributing and collecting chamber were analyzed. The complete system of equations for the hydraulic calculation of the reactor, describing the flow of the coolant from the inlet in the distributing collector up to the output from the collecting chamber, were given. The profile of the distributing collector, guaranteeing the uniform distribution of the coolant discharge, was calculated from the equations of motion of the variable-mass liquid. The utilization of the equations of motion of the variable-mass liquid in the hydraulic calculation of reactors was hampered by the lack of reliable data on the coefficient of hydraulic friction during flow. Conclusions were made on the possibility of experimental investigation of hydraulic resistance. (tr-auth)

7929 THE CALCULATION OF THE ABSORBED DOSE CAPACITY FROM γ SOURCES OF SPENT REACTOR FUEL ELEMENTS. Drozdov, V. E.; At. Energ. (USSR), 23: 120-3(Aug. 1967). (In Russian).

Approximate analytical expressions for the calculation of the absorbed dose capacity from linear γ sources of spent fuel elements with cosine distribution of the activities were derived. It was shown that the non-uniformity of the field of absorbed dose capacity from the spent fuel elements can be 5 and more. For calculation of the repeated scattering of the radiation in matter it was expedient to use the accumulation factor in the integral form. A satisfactory agreement of the values calculated by the formulas and the experimental values of the absorbed dose capacity was obtained. (tr-auth)

7930 EFFECT OF THE MIGRATION OF THE FISSION PRODUCTS ON THE MEASUREMENT OF THE BURNUP IN FUELS. Miller, O. A.; Demidov, A. M.; Galakhmatova, B. S. At. Energ. (USSR), 23: 124-5(Aug. 1967). (In Russian).

The results of the measurement of the distribution along the fuel element of the fission products ^{137}Cs, ^{95}Zr, and ^{144}Ce were reported. The fuel element material is sintered UO_2. The maximum burnup is 68,000 MWd/t of uranium. The measurements were made by means of a γ spectrometer with germanium-lithium detector. In the γ spectrum of the fuel elements, peaks at energies of 661 keV (^{137}Cs), 695 keV (^{144}Ce), 725 keV (^{95}Zr), and 2190 keV (^{144}Ce) could be easily separated and peaks at 758 keV (^{95}Zr) and 766 keV (^{95}Nb) could be partially resolved. The distribution of ^{144}Ce along the fuel element practically coincide with the values expected from calculations. The concentration of ^{137}Cs is 3 to 4 times higher at the tips of the fuel than in its middle sections and of ^{95}Zr 1.2 times higher in the middle part of the element. The migration of ^{137}Cs through the fuel element is connected with the appearance in the UO_2 at high temperatures and extended irradiation of a large number of micro- and macrofissures which leads to the equalization of the distribution of the gaseous fission product ^{137}Xe ($T_{\frac{1}{2}}$ = 3.9 min) through the volume of the fuel element. ^{137}Cs resulting from this (t_{boil} = 630°C) was concentrated at the cooled end of the fuel element. Zr and Nb have high melting points (1860 and 2415°C) and their gaseous predecessor—Kr—has a short decay period. The movement of the Zr and Nb caused the thermal diffusion in the area of high temperatures. The measurements of the migration of fission products along the fuel element by means of spectrometer can yield information on the operating temperature and state of combustion in the fuel element without its destruction. (tr-auth)

7931 FUEL ELEMENT CONTAINING ACTIVATED CARBON. Watson, James F.; Goeddel, W. V. (to U. S. Atomic Energy Commission). U. S. Patent 3,356,586. Dec. 5, 1967.

A nuclear fuel element with improved heavy metal ion fission product retention is described. The fuel element includes high surface area activated C dispersed within a fuel chamber in which nuclear fuel particles are disposed. (AEC)

7932 VENTED FUEL SYSTEM. Zebroski, Edwin L. (to U. S. Atomic Energy Commission). U. S. Patent 3,356,585. Dec. 5, 1967.

A vent is described for a nuclear reactor fuel element permitting the delay of gaseous and volatile fission products until a substantial portion of the radioactive precursors have decayed and control of the release of long-lived gaseous and volatile radioactive fission products. (AEC)

7933 IDENTIFICATION OF NUCLEAR REACTOR PARAMETERS THROUGH SPACED REACTIVITY INSERTIONS. Kadavanich, Kunjara. Lafayette, Ind., Purdue University, 1967. 148p.

Thesis.

The identification problem of a nuclear reactor system has been solved by means of the quasilinearization method. The project had two main purposes. The first one was to investigate the feasibility of a main component called identification for the on line adaptive control of nuclear reactors. The second was to determine the values of the parameters β and l which appears in the reactor kinetics equations. The workability of the method was demonstrated using data obtained from simulated experiments on an IBM 7090 computer as well as data from an actual measurement performed on the PUR-I reactor. Because of the rapid convergence of the solution and the simplicity of the measurement it was concluded that the identification component for on line adaptive control of nuclear reactors could be implemented in real time. It was also concluded that the parameters β and l could be determined separately from data obtained from the measurements. This work gives rise to a new reactor kinetics computer code which is also applicable to other identification problems of both linear and nonlinear systems whose parameters are essentially constant with respect to time. (Disser. Abstr.)

7934 LOGARITHM-AMPLIFICATION REACTOR-PERIOD METER. Tsuchiya, Toyohiko (to Hitachi Ltd.). Japanese Patent 1967-5156. Mar. 2, 1967. Filed Oct. 23, 1964.

An improved method is proposed for detecting rapidly the reactor output and the output change-rate by the use of a radiation detector and a logarithm-amplification period meter. In order to reduce the response time, which is very slow at the start-up of a low power reactor, a simulated-signal source is installed between the radiation detector and the logarithm-amplification period meter; this source is operated when required. (NSA of Japan)

GENERAL

7935 (BNL–11716) EFFECTS OF POST-TREATMENT HYDRATION AND DEHYDRATION OF ETHYL METHANESULFONATE-TREATED MAIZE SEEDS. Briggs, R. W. (Brookhaven National Lab., Upton, N. Y.). [1966]. 13p. (CONF-670942–1). Dep. CFSTI.

From FAO/IAEA Panel on Induced Mutations in Plant Breeding, Meeting, Vienna, Austria.

Conditions that modify the effectiveness of an EMS treatment are duration of post-soaking seeds in water (0 to 48 hr) before drying them, concentration of mutagen, storage temperature (−20° and 25°C), and duration of storage (0, 4, and 8 wk) after treatment. The effectiveness is the amount of biological effect (damage), as measured by reduced plant height and survival, relative to dose. The EMS, in an aqueous phosphate buffer (0.1 M) at 25°C, was used in concentrations from those producing very little effect (0.00125 M) to those producing a severe effect (0.08 M). Post-treatment hydration (i.e., soaking the seeds in water after EMS treatment and before drying) was generally beneficial, on the basis of improved plant height and survival, particularly with the higher concentrations of EMS. In fact there was no survival with the 0.08 M EMS treatment unless the seeds were post-soaked for at least 36 hr before drying. If the seeds were dehydrated immediately after chemical treatment, plants survived only relatively low doses of EMS (0.01 M). Therefore, the effectiveness of a mutagen treatment is increased (more reduction in plant height and survival) if the seeds are dried without post-soaking. Seeds stored at 25°C generally exhibited more reduction in plant height and survival than those stored at −20°C, especially after the higher concentrations of EMS. In many cases treated material stored for 8 wk showed a greater reduction in plant height and survival than material stored for 4 wk. Since modification of the effectiveness of EMS is feasible, it may also be possible to modify the efficiency, defined as the rate of gene mutations relative to biological damage. (auth)

7936 (BNWL–610) UNIVAC 1108/PDP-7 MAGNETIC TAPE COMPATIBILITY PROGRAM I. Wells, E. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1966]. Contract AT(45-1)-1830. 25p. Dep. CFSTI.

A magnetic tape compatibility program has been developed to allow for expansion of CSE PDP-7 computer programs. This program has been restricted to the conversion of integer words only. Details of the codes which have been written to convert PDP-7 18-bit words to Univac 1108 (IBM 7090) 36-bit words, are given. (auth)

7937 (BNWL–619) PLUTONIUM ABSTRACTS. VOLUME 7, NUMBER 10. Russell, Barbara G. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 31, 1967. Contract AT(45-1)-1830. 79p. Dep. CFSTI.

Reference on developments in plutonium technology are listed under the following headings: biology and medicine, chemistry, health and safety, metallurgy and ceramics, miscellaneous, physics, propulsion systems and energy conversion, and reactor technology. (M.C.G.)

7938 (COO–1437-3) A STUDY OF MATHEMATICAL MODELS OF MUTATION AND SELECTION IN MULTI-LOCUS SYSTEMS. Three Year Progress Report, December 1, 1964–November 30, 1967. Lewontin, R. C. (Chicago Univ., Ill. Dept. of Zoology). Contract AT(11-1)-1437. 12p. Dep. CFSTI.

Progress is reported on: development of a multi-locus simulator (computer program) for determining gene frequencies; linkage disequilibrium at selected pairs of loci; phenotypic and genotypic means and variances of each kind of locus; synergistic effects of blocks of genes and effects of linkage on gene frequency; use of simulator for studies on multiple heterotic systems; effects of recombination on fitness of populations; development of a quadratic optimum model for determination of equilibrium of genes in quadratic optimum selection; segregation distortion resulting from abnormal gamete production; population dynamics of male-sterile alleles; effects of fluctuating selection in populations of a given size; selection in inbred populations using two-locus polymorphisms in the grasshopper, Moraba scurra; estimation of fitnesses from genotypic frequencies in successive generations; rates of increase of populations of Drosophila; and interaction of genes in determining evolutionary changes in populations. (H.L.W.)

7939 (COO–1668-4) THE INTERACTION OF VITAMIN D PARATHYROID HORMONE AND THYROCALCITONIN. DeLuca, Hector F.; Morii, Hirotoshi; Melancon, Mark J. Jr. (Wisconsin Univ., Madison. Dept. of Biochemistry). Oct. 28, 1967. Contract AT(11-1)-1668. 18p. (CONF-671030–1). Dep. CFSTI.

From 3rd Parathyroid Conference, Montreal, Canada.

Experiments were conducted with rats to determine effects of thyrocalcitonin and parathyroid hormone on bone mobilization mechanism in the presence and absence of vitamin D. The effects of the vitamin in the absence of either hormone were also demonstrated. Graphs are presented to show results of experiments on the action of thyrocalcitonin on serum Ca of vitamin D-deficient rats, and effects of thyrocalcitonin and/or parathyroid hormone on serum Ca of vitamin D-deficient parathyroidectomized rats. (H.L.W.)

7940 (EUR–3297f) LES CELLULES IMMUNOLOGIQUEMENT COMPETENTES. Rapport Annuel 1966. (Immunologically Competent Cells. Annual Report, 1966). (European Atomic Energy Community). 1967. 49p. (In French). Dep.

Immunologically competent cells (ICC) that play an essential role in the practicability of allogeneous grafts and transplantations were studied. The rejection of the graft by its host and, in the case of a graft of allogeneous blood-forming cells, the secondary syndrome that affects the host, are conditioned by these IC cells. During the past year, five main subjects were investigated: the origin of the stock cells that produce the immunologically competent cells; the sensitivity of IC cells when stored in vitro at 37°C; the sensitivity of IC cells to immunodepressive substances; the mechanism of the graft versus host reaction; and the effect of contact of IC cells with the antigen. (auth)

7941 (EUR–3616d) STUDIE UEBER DIE EINFLUESSE VON ENTWICKLUNGEN IN DER KERNTECHNIK AUF DIE HERKOEMMLICHE INDUSTRIE. (Study on the Influence of Nuclear Developments on Conventional Industry). (Kienbaum Unternehmensberatung G.m.b.H., Gummersbach (West Germany)). May 31, 1967. Contract 033-61-1 ECID. 680p. (In German).

Many branches of industry have been, and are still being, indirectly influenced by developments which had their origin in nuclear technology. This so-called spin-off has led to a number of important, advances in the most widely differing fields. Results of a study which can be regarded as a first step towards the systematic investigation of both the technical and the consequent economic and social effects of nuclear technology on conventional industries are reported. The study was based on a representative inquiry conducted among research centers and industrial enterprises. Investigations were classified according to a numbering system which, together with a code for the fields of application, forms the basis for a numerical listing and evaluation of the data. Despite the introductory nature of this initial study, valid assertions can be made concerning the principal mechanisms governing the transfer of nuclear developments to conventional fields. The intensification and perfection of the transfer mechanisms should give a new impetus to the economy. (auth)

7942 (GEPP–13) DETECTION OF STRAINS IN TUBE ENVELOPE GLASS FRAMES. Howell, J. F.; Pearson, A. W. (General Electric Co., St. Petersburg, Fla. Pinellas Peninsula Plant). Nov. 14, 1967. Contract AT(29-2)-656. 6p. (R67ND10). Dep. CFSTI.

Detection of strains in glass using a polariscope is highly dependent upon the plane of observation relative to the plane of the strain. A technique, which permits detection of strains in cylindrical glass envelopes in both the plane of thickness and the plane of circumference, is discussed. The part to be inspected by the polariscope is immersed in a liquid having an index of refraction which closely matches that of glass. Application of this technique has shown that significant strains are sometimes introduced into glass of tube frames during processing subsequent to tube frame inspection. A majority of strains are detected in the plane of circumference rather than the plane of thickness, which is the plane generally inspected when viewing in air. Polariscope patterns showing both little and considerable strain can be recorded on colored film, and they are useful in training operators to recognize strains in tube envelope glass frames. (auth)

7943 (IARD–67-1) INFORMATION RETRIEVAL IN PHYSICS. Herschman, Arthur (American Inst. of Physics, New York. Information Analysis and Retrieval Div.). Oct. 1967. 21p. (CONF-670414–3).

From Meeting of the American Physical Society, Washington, D. C.

The present physics information system used by the AIP is reviewed and plans for constructing a new system are discussed. The current program is searching for the optimum method of document analysis, storage, and retrieval. (W.H.K.)

7944 (IS-T-207) EIGENVECTORS OF A GENERAL COMPLEX MATRIX BY NORM REDUCTION. Erisman, Albert Maurice (Ames Lab., Iowa). Aug. 1967. Contract W-7405-eng-82. 57p. Dep. CFSTI.

Thesis.

Eigenvectors of a real matrix are found by applying the theorem: "$A\,\bar{x}\,\bar{y}^* - \bar{x}\,\bar{y}^* A = 0$ if and only if $\bar{x}$ and $\bar{y}^*$ are column and row eigenvectors respectively of the matrix A corresponding to the same eigenvalue." It is shown that it is sufficient to consider real matrices since any complex matrix A can be transformed to a real matrix whose eigenvalues are those of A along with the conjugates of those of A. Questions relating to convergence of the method used are considered. This method has application to finding all eigenvectors, some eigenvectors, or correcting approximate eigenvectors. Examples illustrating the first and third of these applications are given. (auth)

7945 (LA-3754) THE 1965 ARPA-AEC JOINT LIGHTNING STUDY AT LOS ALAMOS. VOLUME I. THE LIGHTNING SPECTRUM. CHARGE TRANSFER IN LIGHTNING. EFFICIENCY OF CONVERSION OF ELECTRICAL ENERGY INTO VISIBLE RADIATION. Connor, T. Robert (Los Alamos Scientific Lab., N. Mex.). May 1967. Contract W-7405-eng-36. 32p. Dep. CFSTI.

Studies were made of the optical and electromagnetic emissions of lightning at Los Alamos, N. M., to obtain information for improving lightning discrimination methods in high altitude air fluorescence detection systems. The analysis and evaluation of these spectra and correlated electric field data are included. (M.O.W.)

7946 (LA-3759) FABRICATION OF A COAXIAL SHOCK-SENSITIVE SWITCH. Kirby, R. S. (Los Alamos Scientific Lab., N. Mex.). Feb. 1967. Contract W-7405-eng-36. 7p. Dep. CFSTI.

A technique was developed for fabricating a coaxial switch using metal inner and outer conductors separated by a CdS insulation which becomes an electrical conductor on exposure to an explosive shock wave. Coaxial assemblies of 0.040 and 0.025 in. o.d. were fabricated using a copper outer conductor and an 1100 Al inner conductor. (auth)

7947 (LA-3762) RECURSIVELY DEFINED GEOMETRICAL OBJECTS AND PATTERNS OF GROWTH. Schrandt, R. G.; Ulam, S. M. (Los Alamos Scientific Lab., N. Mex.). Aug. 15, 1967. Contract W-7405-eng-36. 19p. Dep. CFSTI.

Illustrations are given of computer-generated patterns exhibited by figures growing according to certain recursive rules. Examples of growing patterns in two- and three-dimensional space are given. Patterns are discussed in an infinite strip of a given width where periodic growth is observed. When modification of the rules of growth allows portions of the pattern to die out, configurations split into separate connected pieces, exhibiting the phenomena of both motion and some self-reproduction. A simple conflict rule together with this modification allows a game of survival between two systems growing in a finite portion of the plane. The examples show both the complexity and richness of forms obtained from starting with a simple geometrical element and the application of a simple recursive rule. (auth)

7948 (LA-3771) THE TWO-DIMENSIONAL HYDRODYNAMIC HOT SPOT. VOLUME IV. Mader, Charles L. (Los Alamos Scientific Lab., N. Mex.). July 27, 1967. Contract W-7405-eng-36. 31p. Dep. CFSTI.

The failure of a nitromethane detonation resulting from a side rarefaction cooling the explosive inside its reaction zone was calculated using an Eulerian, reactive, numerical, hydrodynamic code. The velocity of the rarefaction agreed with the experimental measurements of Davis. The formation of hot spots from the interaction of a shock in nitromethane with a cylindrical or rectangular void, and the failure of the hot spot to initiate propagating detonation as a result of the rarefactions interacting with the reaction zone were computed. The interaction of the hot spots formed from several voids was computed. The basic two-dimensional processes involved in the shock initiation of heterogeneous explosives are numerically described. Future studies of the basic processes will require three-dimensional geometry. (auth)

7949 (LA-3792) MADMAC, A MADCAP VERSION OF DEC CODE MACRO-8 FOR ASSEMBLING PDP-8 CODES ON MANIAC. Larson, Allen C. (Los Alamos Scientific Lab., N. Mex.). Sept. 22, 1967. Contract W-7405-eng-36. 30p. Dep. CFSTI.

An assembler for PDP-8 codes written in a subset of the DEC-MACRO-8 languare has been entirely written in the Maniac II compiler language MADCAP. This assembler will accept input from cards of paper tape. The paper tape can either be punched in the Maniac character code or in the ASCII character code. The major difference between MACRO-8 and MADMAC is that MADMAC does not have the macro pseudo-op. (auth)

7950 (LA-3819) THERMODYNAMIC TREATMENT OF ANION-EXCHANGE ABSORPTION OF METALS. Coleman, James S. (Los Alamos Scientific Lab., N. Mex.). Oct. 1967. Contract W-7405-eng-36. 7p. Dep. CFSTI.

A thermodynamic description is given of the equilibrium distribution of a metal between an aqueous phase and an anion exchanger. The approach follows the lines established by Fronaeus, Marcus and Coryell, and Kraus and Nelson. Explicit account is taken of stepwise complex formation in each phase, Donnan invasion of the resin, and the formation of polymerized, hydrolyzed, and weakly acid complex ions. (auth)

7951 (LA-DC-8956) DEFLAGRATION OF SECONDARY EXPLOSIVES BY SLOWLY EXPLODING WIRES. Reithel, Robert J. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 20p. (CONF-671044-1). Dep. CFSTI.

From 4th Conference on the Exploding Wire Phenomenon, Boston, Mass.

A slowly exploding wire can be used to ignite deflagrations in PETN and other secondary explosives if the necessary degree of confinement of the explosive charge is present and if the elements of the electrical circuit used to explode the wire are chosen to insure the formation of an arc subsequent to the explosion of the wire. The voltage to which the capacitor must be initially charged to effect a deflagration is a function of the particular explosive and of the density of the explosive charge. Experiments on the degree of confinement required for the deflagration of the explosive charge indicate that a threshold value of pressure in the charge must be attained before the deflagration becomes self-sustaining. The density of the explosive charge affects the rate at which pressure of the decomposition products can reach the threshold pressure. Therefore the voltage to which the capacitor must be charged to result in a bridgewire explosion and an arc sufficient to effect a deflagration decreases as the density of the explosive charge increases. As a result of these factors, electroexplosive devices containing only secondary explosives may be fired at much lower voltages than those characterizing the initiation to detonation of the same explosives by rapidly exploding wires. (auth)

7952 (MLM-1396) DETERMINATION OF DEBYE TEMPERATURES FROM X-RAY DATA AND THEIR USE IN CALCULATING THERMODYNAMIC PROPERTIES. Hunt, D. J.; Ishida, Y. G. (Mound Lab., Miamisburg, Ohio). Feb. 20, 1967. Contract AT-33-1-GEN-53. 21p. Dep. CFSTI.

It is shown that Debye temperatures can be successfully determined from x-ray measurements and used to give reasonable values of thermodynamic and physical properties. (38 references) (M.C.G.)

7953 (NYO-910-61) PHYSICAL-CHEMICAL STUDIES OF NUCLEIC ACIDS AND DERIVATIVES. Progress Report, April 1, 1966-March 31, 1967. Petermann, Mary L.; Cavalieri, Liebe F. (Sloan-Kettering Inst. for Cancer Research, New York). Aug. 15, 1967. Contract AT(30-1)-910. 4p. Dep. CFSTI.

Progress is reported on: effects of temperature, ethanol, formamide, and urea on dissociation of rat liver ribosomes; separation of ribosomal subunits by zonal centrifugation in sucrose gradients; separation of ribosomal proteins by electrophoresis in polyacrylamide gels; studies on ribosomes of Chlamydomonas chloroplasts; purification of DNA polymerase by acrylamide gel electrophoresis; and isolation of RNA from Rous Sarcoma virus. (H.L.W.)

7954 (NYO-3228-9) SPACE CHARGE DISTRIBUTION AT SILVER CHLORIDE-AQUEOUS SOLUTION INTERFACE. Steidel, C. A.; Hoyen, H. A. Jr.; Li, Che-yu (Cornell Univ., Ithaca, N. Y. Dept. of Materials Science and Engineering). June 1967. Contract AT(30-1)-3228. 38p. (CONF-670625-3). Dep. CFSTI.

From International Symposium on Kinetics of Reactions in Ionic Systems, Alfred, N. Y.

Transport phenomena at the interface between a silver chloride single crystal and aqueous solutions of different silver ion concentrations were studied. The nature of the space charge distribution at this interface was investigated. Single crystals of silver chloride with a controlled doping level and crystallographic orientation were used. The experiments include conductance measurements, applied dc potential relaxation studies, and some ac con-

ductance and capacitance measurements. The results of all these experiments are consistent showing that a significant portion of the space charge distribution exists at the solid side of the interface. The theory of Grimley and Mott on space charge distribution is modified in order to interpret the experimental results and to account for the origin of the space charge distribution. (auth)

7955 (ORNL-P-3466) HORMONAL REGULATION OF ENZYME SYNTHESIS. Kenney, Francis T.; Holten, Darold; Hager, Chester B. (Oak Ridge National Lab., Tenn.). [1967]. Contract W-7405-eng-26. 16p. (CONF-670829-1). Dep. CFSTI.

From Symposium on Endocrinology, Kusatsu, Japan.

Results of studies designed to show that synthesis of tyrosine aminotransferase can be altered in vivo by three protein hormones are presented. Synthesis of the enzyme, which is induced by glucocorticoid hormones, was altered in the absence of adrenal steroids (adrenalectomy in an actinomycin D- and puromycin-sensitive fashion). It was found that insulin and glucagon affected an induction, i.e., elevated the rate of enzyme synthesis, and that the hypophyseal growth hormone stopped synthesis or brought about repression. The mechanisms involved in these hormonal regulations of tyrosine aminotransferase synthesis are discussed. (B.H.S.)

7956 (ORNL-TM-2047) CONTAINERS FOR MOLTEN FLUORIDE SPECTROSCOPY. Toth, L. M. (Oak Ridge National Lab., Tenn.). Nov. 8, 1967. Contract W-7405-eng-26. 21p. Dep. CFSTI.

Techniques used previously for visible-uv absorption spectroscopy of molten fluoride salts are reviewed and evaluated. Numerous optical materials that could be useful for fluoride spectroscopy are suggested on the basis of thermodynamic predictions and limited testing. It was concluded that quartz should be used to its practical limits and perhaps then should be coated with transparent metal films in order to extend its usefulness. Ultimately, however, diamond-windowed metal cells are viewed as the only corrosion-resistant absorption cell for fluorides above 500°C. (auth)

7957 (RISO-M-641) ORGANIZATION AND USE OF MAIN LISTS IN MEMORY PDP 8/DR 2 SYSTEM. Goodstein, L. P. (Danish Atomic Energy Commission, Risoe. Research Establishment). Oct. 1967. 14p. (R-20-67). Dep.

This report has been prepared for users of the PDP 8/DR 2 system which is currently under development. It describes the organization of and access to parameters stored in memory which are related to the data collected from the process. (auth)

7958 (SC-CR-67-2688) FUSION OF SOILS. Post, J. L. (New Mexico Univ., Albuquerque. Eric H. Wang Civil Engineering Research Facility). July 1967. 99p. Dep. CFSTI.

A method is provided for predicting the melt ranges of soils with ensuing vapor and gas losses; previously determined soil mineral fusion data are correlated; test soils are selected which are representative of predominant and extreme soil types of the world with their mineralogical analyses and melt range predictions given; and the results of nine soil fusion tests are included. (auth)

7959 (SC-CR-67-2805) THE EFFECT OF INITIAL TEMPERATURE ON THE SHOCK SENSITIVITY OF GRANULAR EXPLOSIVES. First Annual Report Covering the Period August 5, 1966 to August 5, 1967. Roth, J.; Blackburn, J. H. (Sandia Corp., Albuquerque, N. Mex.). Aug. 28, 1967. Contracts AT(29-1)-789; 58-1348. 94p. Dep. CFSTI.

Shock initiation of six granular high explosives was studied at loading density 0.9 of the crystal in a ½-in. gap-test geometry. Hexanitrostilbene (HNS) was also studied by the plane-wave wedge technique. The tests were carried out at room temperature and at various preheat temperatures. Preheating sensitized all but one of the explosives to shock. PBX 9404, a nearly voidless mixture consisting primarily of HMX, had the same shock sensitivity at 25 and at 160°C. The degree of sensitization of HNS varied nonlinearly with preheat temperature—very mildly up to about 110°C, more markedly above 200°C. The other five explosives, RDX, PETN, NONA, PBX 9404, and HNAB were examined at only two temperatures. Shocks in granular explosives can, according to the strength of the shock, produce detonation, partial chemical reaction without detonation, or simple compaction of the explosive. Only at very low pressures can the explosives sustain passage of a shock with no permanent effects of any kind. Equation of state data were obtained for all six explosives. These data may be used to predict shock effects and to calculate shock transmission across boundaries in practical explosive devices. (auth)

7960 (SC-DC-67-2355) MACHINE TOOL OPERATIONS WITHIN IMOG AGENCIES. Quigley, E. P. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1967. Contract AT(29-1)-789. 16p. Dep. CFSTI.

The past problems, current development, and future needs of the IMOG (Interagency Mechanical Operations Group) agencies are discussed. Past problems principally involved inadequate communication, but a few typical examples of equipment difficulties are also cited. Current developments are generally aimed at acquiring a better understanding of the characteristics of new technologies such as hydrostatic bearings, to see if it would be advantageous to use them. Future needs are forecast to enable machine tool builders to plan ahead for new equipment and to provide a basis for better communication. (auth)

7961 (SC-DR-67-725) PULSED ARC SPOT WELDER. Davis, M. J. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1967. Contract AT(29-1)-789. 22p. Dep. CFSTI.

The design and operation of a tungsten inert gas arc spot welder are described. Arc durations from 0.005 to 0.040 second are available with peak currents varying from 8 to 240 amps. Examples of typical applications are given. The equipment is used for the assembly of small electrical and mechanical devices. (auth)

7962 (SC-DR-67-754) DOWNHOLE COMPASS SYSTEM. Noel, Bruce (Sandia Corp., Albuquerque, N. Mex.). Oct. 1967. Contract AT(29-1)-789. 24p. Dep. CFSTI.

The theory, operational procedure, and calibration procedure for a downhole compass system are discussed. The system is used to determine the azimuthal orientation of an instrument canister in a deep hole. (auth)

7963 (SC-DR-67-816) PHASE VELOCITIES OF ELASTIC WAVES IN STRUCTURAL COMPUTER PROGRAMS. Krieg, R. D. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1967. Contract AT(29-1)-789. 41p. Dep. CFSTI.

Dynamic structural computer programs can generally be described by the matrix equation: $M\{\ddot{q}\} + K\{q\} = \{f(t)\}$ where M and K are mass and stiffness matrices, respectively, and $\{q\}$ and $\{f(t)\}$ are column matrices of generalized displacements and forcing functions. The behavior of the simple central differenced time solution of this equation is investigated analytically. The investigation goes a step beyond a stability analysis since the behavior of the solution for all stable time steps is investigated. In particular, the velocity amplitude of an initial velocity problem will be too high for short wavelengths if the time step size is near critical, and the frequencies of the ordinary set of differential equations above are always lower than from the finite differenced (in time) equations. The results are specialized to a straight elastic beam where phase velocity is investigated. Bending wave velocities are shown to be limited in contrast to the solutions of the analogous partial differential equations. By proper choice of time step size and mesh spacing the phase velocity will lie very near the first mode exact elasticity solution. A mesh size near the beam thickness and a time step size less than 0.8 of the critical should give reasonable results in general. (auth)

7964 (SC-R-67-1232) TECHNIQUE FOR PREDICTING NONLINEAR WIND COMPENSATION OF BALLISTIC ROCKET SYSTEMS. Wilson, G. G. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1967. Contract AT(29-1)-789. 20p. Dep. CFSTI.

Factors affecting the nonlinearities associated with wind compensation of ballistic rocket systems are discussed. A linear wind compensation method, used by Sandia Laboratory since 1959, is presented and extended to account for nonlinear effects. Comparisons between the two methods are made to show expected improvements in accuracy. (auth)

7965 (SC-TM-67-807) SANDIA THICK QUARTZ GAGE QUALITY TESTING AND APPLICATION NOTES. Hutchison, R. E.; Morse, T. B. (Sandia Corp., Albuquerque, N. Mex.). Oct. 1967. Contract AT(29-1)-789. 48p. Dep. CFSTI.

A detailed explanation of shock tube testing as a nondestructive dynamic check on Sandia thick quartz quality is presented. A low-amplitude plane stress is applied over the entire front electrode area and the gage output current terminated in a low impedance at the recording oscilloscope. The test simulates operational conditions with a simple step input allowing abnormal perturbations in the detected stress-time profile, indicative of internal gage faults, to be quickly noticed. Information is provided on material sample bonding, bond tests, and general applications. Several appendices are included which describe the usual inspection procedure and a number of other gage quality tests which have been employed with varying degrees of success. (auth)

7966 (SU-326P12-9) ORIGIN OF EPR SIGNAL I IN PLANTS. Weaver, E. C. (Stanford Univ., Calif. Biophysics Lab.). Aug. 1, 1967. Contract AT(04-3)-326-12. 11p. (CONF-670831-1). Dep. CFSTI.

From Symposium on EPR in Biology, Hakone, Japan.

The response of the EPR signal to single light pulses was investigated in algae. It was found that the rate of rise of the signal with the onset of illumination was slow if the preceding dark period had been a long one, and rapid if the preceding dark period was short. Photosynthetically competent cells from a young culture also had a slower and more complex rise pattern than those from an old culture. Decay times, on the other hand, were most rapid in fresh cells, and became far slower with old, damaged, or fractionated cells. It was concluded that the hypothesis that EPR signal is attributed to the oxidized photoreactive center in plants is valid. (H.L.W.)

7967 (SWRHL-33r) THE POISONOUS PLANTS OF THE U. S. ATOMIC ENERGY COMMISSION'S NEVADA TEST SITE, NYE COUNTY, NEVADA. Brown, Kenneth W.; Smith, Donald D. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Dec. 22, 1966. 74p. Dep. CFSTI.

A list is presented of the poisonous plant species found at the Nevada Test Site. The plants are cataloged according to family, genus, and species. Each species is described, its distribution and habitat given, and the poisonous principle involved is discussed. Symptomatology, pathology, treatment, and prevention in relation to the plant's toxicity are also discussed. (E.R.B.)

7968 (UCRL-13325) FAILURE MECHANISMS OF SHELLS CONFINED IN CAVITIES. Technical Report No. 67-2. Final Report. McGhie, R. D. (California Univ., Davis. Dept. of Civil Engineering). Aug. 1967. Contract W 7405-eng-48. 100p. Dep. CFSTI.

For Lawrence Radiation Lab., Livermore, Calif.

The deformation of a thin circular ring of uniform thickness contained in a rigid circular cavity and having small initial clearance between the ring and cavity is considered. The displacement of the ring produced by an acceleration of the rigid cavity in the plane of the ring is analyzed using nonlinear shell theory. Steady state acceleration only is considered so that the inertia forces can be treated as static loads. Design parameters considered are initial clearance, ring thickness and acceleration magnitude. The friction between the ring and cavity is assumed to be zero. Numerical values of the solution to the linear portion of the governing equations are compared with available test data. (auth)

7969 (UCRL-17622) A DATA LINK BETWEEN SMALL COMPUTERS AND A CDC 6600. Andreae, Sypko W.; Lafore, Robert W. Jr. (California Univ., Berkeley. Lawrence Radiation Lab.). Oct. 26, 1967. Contract W-7405-eng-48. 9p. (CONF-671026-11). Dep. CFSTI.

From 14th Nuclear Science Symposium, Los Angeles, Calif.

A data link system which connects small computers (mostly PDP5's and PDP8's) operating on-line with high-energy physics experiments to a CDC 6600 computer at LRL is described. The small computer provides data acquisition and simple checks on the experiments while the CDC 6600 provides final analysis of the data. (B.G.D.)

7970 (UCRL-50356) SPECIFIC COMMON CHROMOSOMAL PATHWAY FOR THE ORIGIN OF HUMAN MALIGNANCY. Gofman, John W.; Minkler, Jason L.; Tandy, Robert K. (California Univ., Livermore. Lawrence Radiation Lab.). Nov. 20, 1967. Contract W-7405-eng-48. 77p. Dep. CFSTI.

A method was developed for the quantitative study of human chromosome constitution, utilizing an electronic scanner and computer analysis of the scans produced. This was utilized for a major objective of our research, a quantitative evaluation of the Boveri hypothesis of a chromosomal imbalance origin of malignancy in humans. Seven established human cell lines, capable of unlimited growth, including three originating from malignant human explants, were quantitatively evaluated for chromosome constitution. In addition, to preclude the possibility that culturing, per se, might account for features associated with unlimited growth, two fresh human cancers without any intervening culture were studied. A variety of normal diploid human cells of both sexes was used as controls. The findings led to the following conclusions: There exists an invariant common to unlimited proliferation of human cells in vitro and to malignant growth in humans. This invariant is in the form of a marked excess of E1 6 chromosomes, either absolute or relative to other classes of chromosomes. This specific chromosomal abnormality may represent a common pathway for development of malignancy irrespective of the primary factor responsible for the existence of cells imbalanced in this manner. From the evidence developed concerning the finite life span of normal human diploid cultures, it appears that not only is E1 6 chromosome excess associated with unlimited proliferation, but E1 6 deficiency develops concomitantly with loss of proliferative capacity. It is felt that Boveri's original hypothesis is confirmed through the quantitative evidence presented here. (auth)

7971 (BNL-tr-168) ON THE SURFACE STATE OF PLATINUM ANODE FOR ELECTROYLTIC PERSULFATE MANUFACTURE BY X-RAY EXAMINATION. Inoue, Toshio. Translated from Denki Kagaku, 25: 576-83(1957). 19p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

To obtain information about the electrolytic reactions on platinum anodes, the surface states of platinum anodes used in the electrolytic production of ammonium persulfate were investigated. Prior to electrolysis the platinum electrodes showed attenuation of the (111) diffraction ring and an unusually strong (220) ring. After electrolysis the (111) ring appeared, and the diffraction intensity of the (220) ring declined in comparison with the characteristic intensity, while the original lustre and smoothness of the platinum electrode surface had disappeared and phenomena anodic dissolution were noted. After electrolysis a platinum anode showed the diffraction ring of Pt_3O_4. The diffraction ring due to the $PtO_2 \cdot NH_2O$ structure was extremely weak. The yellow-brown layer noted on the platinum anode surface after electrolysis had a crystal structure classified as tetragonal symmetrical and is considered to be a complex salt or double salt. (M.C.G.)

7972 (IS-Trans-74) APPLICATION OF THE GALYERKIN METHOD TO THE PROBLEM OF THE STABILITY OF UNEVENLY HEATED LIQUIDS. Zhukhovitskii, E. M. Translated by E. E. Conrad (Iowa State Univ., Ames), from Prikl. Mat. Mekh., 18: 205-11(54). 15p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

A method is described for determining the conditions at the inception of thermal convection in a liquid heated from below. Examples are given using vertical and horizontal vessels. (F.S.)

7973 (LA-tr-67-105) ALGORITHMS AND RANDOM SEQUENCES. Martin-Lof, Per. Translated by W. A. Beyer for Los Alamos Scientific Lab., N. Mex., from four lectures given at the Mathematics Institute, Erlangen University, Nuremberg. 55p. Dep. CFSTI. JCL $5.60 fs, $1.85 mf.

A new definition of the concept of random sequence is presented and discussed. It depends on the theory of algorithms developed from the point of view of different logics in different, but equivalent, formulations. Discussed are recursively enumerable sets, definition of finite random sequences, and infinite sequences. (W.H.K.)

7974 (ORNL-tr-1778) METHOD OF DETERMINING FREE CARBON IN BORON CARBIDE. DETERMINATION OF IMPURITIES IN BORON CARBIDE (PART 1). Kitahara, Saburo; Asahara, Hiromasa; Atoda, Tetsuzo. Translated for Oak Ridge National Lab., Tenn., from Rika Gaku Kenkyusho Hokoku, 34: 339-43(1958). 10p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Treating boron carbide with $K_2Cr_2O_7-CrO_3-H_2SO_4$ dissolves the free carbon but does not attack the boron carbide. This permits separation of the two components after which the free carbon can be determined quantitatively. An oxidizing medium of KIO_3 and H_3PO_4 can also be used to separate the free carbon from boron carbide. (M.C.G.)

7975 (ORNL-tr-1826) THE PLASMA JET AS A NEW LIGHT SOURCE AND EMISSION SPECTRAL ANALYSIS USING A PLASMA TORCH. Goto, Hidehiro; Atsuya, Ikuo; Suzuki, Mitsuaysu. Translated for Oak Ridge National Lab., Tenn., from Bunseki Kagaku, 16: 735-47(1967). 23p. Dep. CFSTI. JCL $2.60 fs, $0.95 mf.

Use of the plasma jet and plasma torch in emission spectroscopic analysis is discussed. Topics covered include: relation between operating conditions and spectral line intensities, characteristics of the plasma flame, problem of background intensity, sensitivity, precision, calibration curves, solvent, effect of coexisting elements, principles of spectroscopic analysis with a plasma torch, temperature distribution curve of the plasma torch, and comparisons of the plasma jet and plasma torch. (M.C.G.)

7976 (SC-T-67-0957) INTRODUCTION OF A MODEL FOR THE STRUCTURE AND MOVEMENTS OF THE ATMOSPHERE AT AN ALTITUDE OF FROM 85 km TO 110 km. Blamont, J. E.; Barat, J. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.), from Ann. Geophys., 23: 173-95(1967). 57p. Dep. CFSTI. JCL $5.60 fs, $1.97 mf.

After demonstrating, using a sodium cloud between 85 and 110 km, that the observed turbulent phenomena are purely natural, it is shown that a stratification of turbulent phenomena corresponding to a free turbulent field exists in this region. In inertial subranges of Kolmogoroff movements of the order of 4 to 500 meters can be observed in the turbulent parts. From 500 meters to 2.5 km turbulent movements are controlled by vertical gradient of

average wind following Tchen's law. It is shown that turbulent phenomena can possibly be related to organized movements of local extension. Turbulence disappears with the upward propagation of the movements when their energy decreases because of turbulent phenomena created in the lower regions. (auth)

7977 (UCRL-Trans-10140) EXPLOSION. Pokrovskii, G. I. Translated by T. Lazar for Univ. of California, Lawrence Radiation Lab., Livermore, from Vzryv, Izdatel'stvo Nedra, Moscow, 1964. 171p. Dep. CFSTI. JCL $12.50 fs, $5.60 mf.

A general review of the physical nature of explosions is presented in a form intended for readers in all professions. A brief history of the use of explosives is followed by a discussion of types of explosives, their sensitivity, methods of initiation of explosions, and the hydrodynamic theory of explosions. Explosions in air and water and the resulting shock waves are described in some detail. Uses of explosives in mining, in construction, and in molding of materials are discussed. (A.G.W.)

7978 (UCRL-Trans-10156) ANALYSIS OF ICE DRIFT BY THE WATANABE METHOD. Tsurikov, V. L. Translated by Robert Addis for Univ. of California Lawrence Radiation Lab., Livermore, from Okeanologiya, 4: 904-7(1964). 7p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

A mathematical analysis of iceberg drift is given. Consideration is included for current, surface current, and tides. (F.S.)

7979 (UCRL-Trans-10161) MICROTITRATIONS WITH ETHYLENEDIAMINETETRAACETIC ACID. PART XII. DETERMINATION OF GALLIUM. Flaschka, H.; Abdine, H. Translated by Z. F. St-Gallay for Univ. of California Lawrence Radiation Lab., Livermore, from Mikrochim. Acta, 6: 657-67(1954). 20p. Dep. CFSTI. JCL $2.60 fs, $0.83 mf.

The theoretical basis of the complexometric titration of gallium is discussed. The behavior of gallium is compared with that of other group IIIA metals. Gallium is determined by back-titrating excess EDTA with a solution of Zn, Mg, Cu, or Pb in the presence of various indicators and at various pH values. By back-titrating with a lead salt solution, one can determine gallium in the presence of Zn, Cu, Co, Ni, and Fe, provided that these metals are masked with potassium cyanide. It is possible to determine gallium in the presence of large amounts of alkaline earth metals by back-titration of excess EDTA with a zinc or a copper solution at pH < 6. (auth)

7980 (UCRL-Trans-10164) INITIATION OF DETONATIONS OF COMPACTED EXPLOSIVES BY RADIATION OF AN OPTICAL QUANTUM GENERATOR. Brish, A. A.; Galeev, I. A.; Zaytsev, B. N.; Sbitnev, E. A.; Tatarintsev, L. V. Translated by J. Mulhaus for Univ. of California Lawrence Radiation Lab., Livermore, from Fiz. Goreniya Vzryva, No. 3, 132-3(1966). 5p. Dep. CFSTI. JCL $1.10 fs, $0.80 mf.

Detonation in lead azide and in pentaerythritol tetranitrate by the action of an optical quantum generator (OQG) was obtained in conditions of quality factor modulation on the experimental setup. The active element in the OQG is neodymium glass measuring 10 × 120 mm; transmission factor of the fixed mirror is 35%. The output pulse of the OQG has a power of up to 10 Mw, a duration of 0.1 μsec (energy of 0.5 joule) and a beam diameter of 15 mm. The action of such an OQG pulse caused the explosion of the sample of lead azide when the power density on the surface of the explosive amounted to 0.08 Mw/mm^2 (energy of 0.1 joule). The explosion of pentaerythritol tetranitrate occurred only at a much higher power density on its surface, which was obtained by focussing of the beam. (M.C.G.)

7981 (WAPD-Trans-80) NEW DATA ON THE DEPOSITION OF CRYSTALLINE SUBSTANCE ON THE WALLS OF A LIQUID INCLUSION. Lemmlein, G. G.; Kliya, M. O. Translated from Dokl. Akad. Nauk SSSR, 82: 765-8(1952). 11p. Dep. CFSTI. JCL $1.60 fs, $0.80 mf.

Different theories relating to the concentrations of aqueous solutions from which crystallization occurs in quartz, feldspar, topaz, beryl, tourmaline, and other minerals in the hydrothermal stage of the pegmatite process are summarized. To explain the jagged contours of the inclusions, new data are used which show that even after a significant decrease in temperature, an appreciable amount of topaz from completely isolated mother liquid is formed on the walls of an inclusion. (F.S.)

7982 ORGANIZATION AND STANDARDS AS ELEMENTS OF RELIABLE MANAGEMENT. Courvoisier, P. Sektion fuer Sicherheitsfragen von Atomanlagen, Wuerenlingen, Switzerland). Neue Tech., 9: 192-7(1967). (In German).

The structure is outlined which an organization for the operation of a nuclear plant should have in order to secure a clear-cut distribution of responsibilities and duties. The organization should be able to produce a set of sufficiently detailed rules of operation for the plant and it should be able to furnish means for an effective survey of plant operations. Operations with the plant which are important from the point of view of safety and which will have to be described by the rules of operations are summarized. (auth)

7983 REACTOR AND FUEL-PROCESSING TECHNOLOGY. Volume 10, Number 3. Dutton, James J.; Lennox, David H.; Brown, Karl K.; Royal, Joseph; Gold, Raymond; Gregory, Paul H. One of the Five Quarterly Technical Progress Reviews Published for the Division of Technical Information, USAEC. Argonne National Lab., Ill., Summer 1967. 78p. GPO $0.70 Domestic, $0.90 Foreign.

Research progress on reactor technology and fuel reprocessing is reported under 9 topics. Separate abstracts were prepared for each topic. (M.C.G.)

For abstracts of individual sections see: 6381–6384, 6605, 7831, 7832, 7926, and 7927.

7984 DEVELOPMENT OF ZONAL CENTRIFUGES AND ANCILLARY SYSTEMS FOR TISSUE FRACTIONATION AND ANALYSIS. Anderson, Norman Gulack (ed.). National Cancer Institute Monograph 21. Bethesda, Md., National Cancer Inst., 1966. 534p. GPO $4.75.

Twenty-nine papers are presented on the theory, design, development, and use of zonal centrifuges. Several zonal rotors and centrifuge systems are discussed in detail to illustrate the development of this major advance in the concept of particle separation. Techniques and data are presented on the applications of zonal centrifugation in a wide variety of research projects involving particle separation at the subcellular and molecular levels. Two papers are included on the use of zonal centrifugation for isolation of virus particles from human plasma. (E.R.B.)